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OUR supply of copies of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, is entirely exhausted. As we need a few, any subscriber who may have a copy of that date, and who does not preserve his files, will confer a favor upon the JOURNAL by sending it to the office. For any copy of that issue sent in, the sender will receive a credit of *two months* on his current subscription.

THE publication of the next article in the series on Practical Railroad Information is necessarily postponed until the February number of the JOURNAL, owing to the fact that its preparation required an extended series of experiments and the use of some testing apparatus made especially for this purpose, which could not be completed in time for the present number.

The value claimed for this series is that it presents facts obtained by careful tests and long experience; and its authors desire to exercise the utmost care in basing their deductions entirely upon such facts. That this, in the present case, involves some delay could not be avoided, and our readers will have the full benefit of the longer time necessary for preparation.

THE removal of the Grant Locomotive Works from Paterson and their establishment on an enlarged scale at Chicago are notable events in their way. A number of engines have been built in railroad shops in the West; but the new Grant Works will be the first large shop building locomotives for sale which has been placed west of Pittsburgh for a number of years. To state all the causes of this would occupy too much space; but there seems to be no reason now why Chicago should not be an excellent location for the works, and it is to be hoped that they will secure there the success which there is every reason to expect for them. The new works will be provided with all the improvements in buildings and plant which long experience in the business may suggest to their owners and builders.

THE Intercontinental Railroad Commission has organized by a choice of Mr. A. J. Cassatt as President, and has begun its work at Washington. At the first meeting there were present representatives from Mexico, Guatemala, Costa Rica, Columbia, Ecuador, Venezuela, Peru, Paraguay, Brazil, and the United States. The Commission has established its headquarters at No. 1016 Vermont Avenue in Washington.

THE Commission appointed to mark out a location for the bridge over the Hudson River at New York has adopted a report indicating the point where the bridge should be built, and the lines for the approaches on the New York side and the connections with other railroads. This report is opposed, as any such location would be, by parties interested, and may not be finally approved. It is said, however, that the company will be ready to begin work as soon as the location is decided and the plans for the bridge itself receive the approval of the Secretary of War, as required by the act of Congress authorizing its construction.

The proposed structure, it will be remembered, is to have a single river span of 2,800 ft., high enough above the water to avoid interference with navigation. The general plan is that of Mr. Lindenthal, though the precise details cannot, of course, be decided on until the questions of location and height are finally settled.

Nothing has yet been definitely announced as to the financial arrangements for building the bridge. Its success will depend very much upon the railroads having their terminal stations on the west side of the Hudson. If they will unite in using it its traffic will probably pay interest upon its cost, but otherwise the return is doubtful, for it will not be so placed as to have at once an enormous local business, like the Brooklyn Bridge.

THE Obelisk in the New York Central Park, which was treated for preservation some time ago, was reported recently to be showing alarming signs of disintegration from the effects of the weather. It was, accordingly, carefully examined by a commission of experts, who have reported to the Park Commissioners that the results of the former preservative treatment were excellent, and that there is no need of any additional protection of the general surface. Certain decayed or decomposed spots exist, however, which they recommend should be further treated by the process originally used—the paraffine process—under the charge of the inventor, Mr. R. M. Caffall. The disintegration in these defective spots probably began, the experts think, before the Obelisk was brought from Egypt.

THE Navy Reports this year show another year of hard work in the extension of the Navy and in building the new

ships and guns which are required for its formation. The Secretary's report, a summary of which will be found on another page, shows what has been done already and what is in progress. The reports of the different bureaus, which are reserved for more extended notice hereafter, will show the work in detail. The Navy Department has been a very busy place for some time past, and promises to be so for some time to come.

THE latest bids for the construction of new ships were opened at the Navy Department on December 20. For the harbor defense ram—better known as the Ammen ram—the only bid was from the Bath Iron Works for $930,000, the ship to be built on the Department plans, except that she shall not be rejected if she fails to make 17 knots an hour.

For Torpedo-boat No. 2 three bids were received. The Herreshoff Company offered to build a boat of the size specified, 112 tons displacement, for $93,200, or one of 140 tons for $125,000, in either case on bidder's plans. The Cowles Engineering Company, Brooklyn, N. Y., offered to build a boat of 112 tons, on bidder's plans, for $119,940.

The contract for the torpedo-boat has not yet been awarded by the Department. That for the ram will be given to the Bath Company.

THE SOCIETY OF CIVIL ENGINEERS ELECTION.

FOR some time past there has been more or less dissatisfaction with the management of this Society. The malcontents gave expression to their discontent in the nominations for officers to be voted for at the next annual election, which is now near at hand. The office of Secretary seems to be the chief point of attack, for which position there are a number of nominees and a good deal of wrangling. The making of nominations goes gayly on, declinations of candidates are numerous, and nearly every clique and community represented in the Society has its own ticket in the field. Legal opinions, pro and con, are quoted with reference to the eligibility of candidates, until the contemplation of the canvass suggests the campaign of Parnell in Kilkenny. One candidate has issued a circular congratulating the Society on the high standard of its membership, and the fact that it has "refrained" from doing some things and has "denied" its approval to others. There seems to be danger that in its efforts to maintain its advanced standard of membership, the more important end of doing useful and profitable work may be lost sight of. The circular referred to also says, that on account of the competition of the various Engineering Journals, which pay more or less liberally for contributions, the Society does not receive many papers that would otherwise naturally come to it. This is rather a grave charge on the members and the Society. If members who write papers prefer the lucre which they get from the Journals to the distinction attending the reading of a paper before an Association with a high standard of membership, it shows that either the members are sordid, or the value of the distinction is low.

That there is some influence in the Society which prevents it from being as useful as it should be, or is needed to make it so, has long been a subject of remark. The present campaign seems to indicate that the defect is an inability on the part of the membership to co-operate for the promotion of the professional usefulness of their organization. For twenty years the constitution has been a perpetual subject of amendment, and no abiding agreement with reference thereto could ever be reached. It is not a great while ago since a Committee of five members was appointed to draw up certain general specifications to secure the safety of iron bridges. When the Committee reported there were five distinct reports—no two members could agree, and the Society never adopted any of them. This inability to concur and work together seems to be a professional defect of civil engineers. It is due perhaps to the fact that success in their calling is not dependent to any very great extent on co-operation with other people. The same trait may be noted in college professors. Mechanical engineers, on the other hand, cultivate a capacity for co-operation, because their success is usually directly dependent upon an extensive and elaborate organization for the manufacture of more or less complicated structures. The usefulness of a manager, or a subordinate officer, of a machine shop would soon reach its end if he was unable or unwilling to concur with his co-workers.

But to return to the election. A campaign like that which has been carried on cannot be of much benefit to the Society, and seems likely to result in a loss of influence and dignity. To a great extent it is a wrangle over the office of the Secretaryship. This would be avoided in future if the Secretary, instead of being elected by a vote of the members, was appointed by the Board of Directors. This would be a benefit in many other ways. The Secretary should be the servant of and be accountable to the Board. They should have entire control of him, with the right of appointment and dismissal. They are the only parties who can know whether he is performing his duties properly or not. If he is not, the Board of Directors should have power to call him to account. A small body of men like the Board would also be much more likely to select a person competent for the position than a nominating caucus will. The Secretaryship is the only salaried office in the Society. It therefore becomes a more or less desirable position to attain to, and there is always the risk that the election may be attended by a discreditable canvass, like the present one. If the Secretary was appointed he would also feel more independent than he can if his name must be submitted annually to the approval of the whole membership, who cannot possibly know what his qualifications are, or how he has performed the duties of his office. His election is a constant temptation to the acquisition of influence over the membership, to strengthen him in the position he occupies. His duties, the control of the correspondence, and other influences, can all be used by him to this end. If he was appointed there would be no occasion to use such arts to make his occupancy of the office secure.

In the Master Car-Builders' Association the Secretary has been appointed instead of elected for the past eight or ten years, and with the result that the method of appointing him has avoided all electioneering and intrigue to secure the position. The clause of the constitution under which he is appointed is as follows:

"A Secretary, who may or may not be a member of the Association, shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus ap-

pointed, unless terminated sooner, shall cease at the first meeting after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall, however, have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by a majority of the Executive Committee."

If the Society of Civil Engineers would adopt this method of appointing, instead of electing, their Secretary, it would be sure to secure more efficient service in that office and avoid in future the discredit of a canvass like the one now going on.

JOHN ERICSSON.

The Life of John Ericsson: by Walter Conant Church. 2 volumes, illustrated. (New York; Charles Scribner's Sons.)

John Ericsson was so great an engineer, and was so completely identified with the progress of engineering during his lifetime; was, in fact, in himself so large a factor in that progress, that it would be entirely out of place here to enlarge upon this point. He was so peculiar in his life and methods of work, that while most engineers fully recognized his greatness, while many respected his authority as a master, and some were, in one way or another, brought into contact with him, very few knew him well personally, and his private and individual life was almost a sealed book to the world. What he accomplished is on record, but how he did it and by what processes he reached his conclusions very few knew.

In writing his life Colonel Church had the advantage of long personal intimacy, and of full access to the papers and letters, granted him at Captain Ericsson's own request. He has made liberal use of these in the work, sometimes in a very interesting way, sometimes, it must be said, in a less artistic manner. The great fault of the book is a tendency to too great minuteness in some points, while others are left with what appears to the reader too little explanation. On the whole, however, it is an exceedingly interesting book, and not only tells the story of his great achievements, but also gives us some idea of what Ericsson the man really was like.

The secret of Captain Ericsson's wonderful success was in his clear perception of principles, his mastery of details, his fertility of resources, and his untiring industry and extraordinary capacity for work. His mind was wonderfully acute, and he could see at once a point which most men could reach only by long study. He had also a great power of expressing his ideas, and could convey them to others with ease. Probably he has never been excelled as a draftsman, and his mastery of that universal language of mechanics was of the greatest possible service to him throughout his active life.

The story of his successes and disappointments, of his trials and failures, is told here in detail. We have something of the early life which trained him for the work which he was to do, and something of the later period which was passed in seclusion from the world and devotion to his work. He was so completely absorbed in this that he cared for little else really, and gave very little time to the society of others, preferring a life which left him free to think and work out the problems which presented themselves to his continually inquiring mind. He had few friends and fewer intimates; and while he valued these few and held them in high regard, yet he always subordinated everything to his work. He was fair and just to other engineers and was always willing to give them credit for good work done, but he fully understood and appreciated his own eminence, and could be, on occasion, very tenacious of his rights.

The picture given us is of a great man, but hardly a lovable one, even though it seems that those who knew him best were very strongly attached to him. It is a most interesting picture, nevertheless, and will well repay a careful reading.

THE INTERSTATE COMMERCE COMMISSION.

Fourth Annual Report of the Interstate Commerce Commission; December 1, 1890. Washington; Government Printing Office.

The Interstate Commission in its present report covers a pretty extensive field. The statement of the work done during the year shows that the Commissioners are not permitted to waste much time, and also indicates some of the difficulties under which they labor. Some instances of the practical working of the law are given, to show its defects and the reasons why less has been accomplished than was expected.

A large part of the report is given up to the discussion of Rates in various forms, to through rates, rate cutting, and rate wars, and to the much-vexed "long and short haul" question. Ticket brokerage and commissions on business are also discussed at some length as a part of the same subject. Something is also said of the consolidation of roads, and of the control of lines by other companies. The Commission speaks now from experience, and has reached a very definite idea of what ought to be done in this direction—which, unfortunately, is very far removed from what is done.

The report also refers to what has been effected by conference with the Railroad Commissioners of the several States. The report as issued does not contain the statistical tables, to which frequent references are made.

In the light of experience, the Commission makes a number of recommendations for amendments to the law. These include a provision to compel roads to co operate in forming through lines; an amendment to make the present act clearer as to the penalties for violation of the law, and provision for bringing suit against corporations themselves; an amendment giving the Commission power to compel the attendance of witnesses; one to authorize free transportation for persons injured on the road and for those going to help them; amendments prohibiting the payment of commissions and the sale of tickets by brokers without authority; regulating mileage charges for the use of cars owned by private companies; giving the Commission authority to call for reports at intervals shorter than a year; and finally making the findings of the Commission final as to fact in a case, subject only to appeal to the United States Circuit Court.

All of these amendments are suggested by experience in the working of the law, and all of them seem to be desirable, if the law is to be executed. That the Interstate Commission has been of advantage both to the people and the railroads will now be admitted much more generally than would have been the case four years ago. That it is so is largely due to the wise selection of Commissioners made in the first place.

THE WASHINGTON BRIDGE.

The Washington Bridge over the Harlem River at One Hundred and Eighty-first Street, New York. A Description of its Construction; by William R. Hutton, Chief Engineer. (New York; Leo Von Rosenberg.)

The deep and narrow valley of the Harlem River north of New York City was crossed a number of years ago by what was then one of the most notable bridges in the country, the stone arch bridge which carries the Croton Aqueduct across the river. The High Bridge, as it is called, was intended for the aqueduct alone, and is not available for ordinary traffic, and it has been necessary to erect near it another notable structure, which is known as the Washington Bridge, and which connects Tenth Avenue in New York with the section of the city known as Fordham Heights on the north side of the river. This bridge consists of two steel arches, one over the river and one over

the railroad tracks and lowlands on its eastern bank, and of masonry approaches which are in themselves arch bridges of considerable size. It is a structure well worth the handsome monogragh in which it is here described.

As we have heretofore remarked, the monograph is frequently a very valuable work to engineers, especially in the department of bridge construction. General principles can be given in the ordinary treatise, but it is only by description of particular structures that we can learn how the details are worked out and adjusted to fit varying circumstances.

The great feature in the book in question is the illustrations. Besides the general views and plans there are photographs of the masonry at different stages of its erection, photographs of the completed bridge, of the iron work, and finally a large number of drawings giving details of the masonry and of the superstructure in a very complete manner. The engravings are excellent, the drawings being clear and fine, and the execution good.

The reading matter includes some historical account of the construction of the bridge, a brief description and copies of the contract and specifications. It is to be repented that greater space was not given to the description, especially of the superstructure. It has been abbreviated so much that it is impossible to understand it properly without reading the specifications also, and many engineers, we think, would have found it much more convenient to have the information without recourse to the latter, which are not always easy reading. The drawings, it may be said, are so complete that it would hardly be possible to suggest any addition.

The mechanical execution of the book is excellent, and the publisher has brought it out in a style which leaves little to be desired, and corresponds to the importance of the book. It may be added that the large plates giving views of the different divisions originally submitted for the bridge form an excellent and very interesting addition.

COMPOUND LOCOMOTIVES.

Information Regarding Compound Locomotives Built by the Rhode Island Locomotive Works: By C. H. Batcheller, Chief Draftsman.

This is a small volume of blue prints attached together, and giving an account of some experiments, or tests, made with a compound and a simple locomotive on The Brooklyn and Union Elevated Railroads, of Brooklyn, N. Y. Both engines were of the Forney type, with two pairs of connected driving-wheels, with a four-wheeled truck supporting the tank. The driving-wheels were 42 in. diameter, loaded with a little over 45,000 lbs. The cylinders of the simple engine were 11½ and 11 in. diameter respectively, with 16 in. stroke. The compound cylinders were 18 and 11 in. diameter, with 16 in. stroke. The engines were alike in every other respect, excepting the cylinders. The experiments were made for the Rhode Island Company, to guide them in designing compound locomotives.

This interesting volume reached us too late to reproduce any of the indicator and other diagrams appended to it, or even to analyze it as fully as it deserves. The compound engine was of the two-cylinder-type, the cylinders being connected by a copper receiver. A reducing valve is placed between the receiver and the boiler, so that the steam-pressure in the receiver is reduced in direct ratio of the piston areas, irrespective of the boiler pressure. This allows the compound to be used as a simple engine, and greatly increases its maximum power. In ordinary circumstances the engine starts from rest as a simple engine, with direct steam in both cylinders, which then have equal power. When the exhaust from the high-pressure cylinder produces the normal pressure in the receiver, the direct steam is automatically cut off from, and the receiver steam admitted into the low-pressure cylinder, and the engine is thus thrown into the compound system.

The road on which the experiments were made is five miles long, and in that distance has 16 passenger stations and two junction points, at which stops were required. The trains consisted of two light passenger cars during the middle of the day and late at night, and three or four cars during morning and evening hours. The running time is 24 minutes.

The experiments consisted of one day's service with each engine. They were started from the yard at East New York, at 6.15 A.M., and ran six miles, with a light four-car train, to Fulton Ferry, where they commenced service, making 22 trips (11 round trips) of five miles each, from Fulton Ferry to Ridgewood and return; then one trip of four empty cars to East New York, six miles, making a total train mileage of one hundred and twenty-two miles from 6.15 A.M. to 8 P.M. The coal used was soft anthracite. The steam-pressure in the simple engine was 140 lbs. and in the compound 155 lbs.

Under these conditions, the experiments showed that during the 13¾ hours that each of the engines were doing practically the same work, the simple engine burned 3,899 lbs. of coal and the compound 2,430 lbs., *or* 37.7 *per cent. less* than the simple engine.

This is a very extraordinary result and deserves careful consideration. The difference of steam-pressure in the two engines will be noted. This, of course, is a disparity in the conditions under which the experiments were made. If there is any advantage in using a high pressure in a simple engine, it should have the advantage thereof in a comparative test of this kind.

The report also shows that the boiler of the compound engine evaporated 8.25 lbs. of water per pound of coal, whereas that of the simple engine evaporated only 6.69 lbs. This is a difference of 23.3 per cent. In other words, as was noted in these pages with reference to the experiments with the Baldwin compound engine, the report shows that the boiler of the simple engine, which is said to be exactly like that of the compound, is nevertheless much less economical. In the language of Artemus Ward, "Why is this thus?" The reason for it is not explained in the report. If the simple engine could have had the advantage of the higher steam-pressure, and if the boiler had been as economical as that of the compound locomotive, it seems probable that the 37.7 per cent. of gain in fuel would be considerably reduced. What the report shows now is that a compound locomotive working at a pressure of 155 lbs., and an efficient boiler, burns less coal than a simple engine with 140 lbs. pressure and an inefficient boiler. No one doubts this, but what we all want to know is how much coal will be saved by a compound locomotive working under the same conditions and with boilers of equal efficiency. What, we think, may be objected to is saving coal in the boiler, and then attributing the advantage to the compound principle of working the engine. It is admitted that if this economy of the boiler is due to, and dependent upon, the compound feature, that it is properly an advantage which may be claimed for that principle, but if the same economy may be obtained with a boiler of a simple engine, then it is not one of the merits of compounding. Thus it may be said, that the more economical working of the boilers is due to the lighter exhaust of compound engines. If that is so, it is an easy matter to make the exhaust of simple engines as light as we choose. It is not asserted here that compound locomotives are not more economical than simple ones, but the extent of the economy is a subject of dispute the world over. Don't let us be misled by experiments which are not conclusive.

The report before us also contains a number of diagrams showing the "stress effects" on the crank-pin, showing that a compound locomotive brings to bear upon the moving parts a more continuous stress, or even while subjecting these parts to loads of less magnitude at the point of maximum stress, and that the effect of the applied power is also more regular in the com-

pound engine. This is a matter of more importance than is generally assigned to it. It is not quite clear, from the description, or the diagrams themselves, whether they take into account the effect of the inertia and momentum of the reciprocating parts, or whether they represent only the steam-pressure on the pistons. The construction of such diagrams is quite a complicated problem, and unless all the elements are taken into account, especially at high speeds, they are apt to be misleading. It is more important, however, that the rotative effect on the crank-pins should be uniform in starting than at considerable speeds, because as soon as the rotative effect exceeds the adhesive, the wheels will slip. Consequently, the maximum rotative effect which can be exerted is that which is equal to the adhesive. Now, it will be obvious that if such a maximum effect is exerted during the whole revolution of the wheels, that an engine will start and pull a heavier train than it would if it is exerted at only one or a few points during a revolution, and falls considerably below this between these points. For this reason it is desirable that the effect should be as nearly uniform as possible during the whole of the revolution of the wheels.

The report of these experiments has been very carefully prepared, and in that respect is a model of its kind, and is very creditable to its author, and to the Company which had the enterprise to have such a series of tests made.

NEW PUBLICATIONS.

THE CATECHISM OF THE LOCOMOTIVE, *Second Edition, Revised and Enlarged:* by Matthias N. Forney, Mechanical Engineer. (The Railroad Gazette; New York.)

In view of what follows, a little explanation is perhaps needed here. The copyright of the original edition of "The Catechism of the Locomotive" was transferred to the present publishers of the *Railroad Gazette* some years ago, with my interest in that paper. The new edition of that book was therefore written under a contract with the present proprietors of the *Gazette*, for the publication of the new edition of the "Catechism." Consequently they are the publishers of the new edition of the book which has just been issued. With its character our readers are already familiar, as nearly the whole of the revised edition has been published in this JOURNAL. As the sub-title indicates, the new edition is revised and enlarged. The old book was $7\frac{1}{4} \times 4\frac{3}{4}$ inches in size; the new one is $8 \times 5\frac{1}{2}$. The old one had 609 pages, the new one has 709. The new edition is printed in type one size smaller than that used in the first, so that the amount of reading matter and the number of engravings is just about doubled. In the preface it is stated that, "since the first edition was written, in 1873, many changes and improvements have been made in the construction of locomotives, so that in preparing a second edition of the book the first one had to be thoroughly revised, and to a great extent rewritten, and a great deal of entirely new matter had to be added to bring it up to the present 'state of the art' of locomotive engineering."

Most of the illustrations are entirely new, and have been selected from the latest practice in this country. Additional chapters have been added on Force and Motion; Resolution of Motion and Forces; the Principles of the Lever; the Action of the Piston, Connecting-rod and Crank; Action of the Pistons, Cranks and Driving-wheels; the Westinghouse Air-Brake; the Care and Use of Air-Brakes; and the Eames Vacuum Driving-wheel Brake.

To make the construction of the Air-Brake clear, a large folded plate, printed in three colors, showing the principal parts of the brake on an engine, tender and car, has been added to the book. There are also five other folded plates showing a stationary engine, a diagram of the motion of a slide-valve, and a side-view, section and plan of an ordinary locomotive.

The presswork is only fairly good—some is positively bad—as, for example, the full-page engravings of locomotives, figs. 100–120. This is, however, largely due to the execrable quality of the paper which the parsimony of the publishers has led them to use, and which is disgraceful to them, an injustice to the purchasers of the book and a cause of mortification to its Author. As an example of the style in which publications are issued by the *Railroad Gazette*, it would seem likely to deter an Author in future from intrusting the issue of his productions to the company which is responsible for printing a respectable treatise on material like that used in the book which is the subject of this notice. M. N. F.

NINTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE SECRETARY OF THE INTERIOR, 1887–88: J. W. Powell, Director. (Washington; Government Printing Office.)

This report shows the progress made by the Survey during the year covered in topographic and geologic work, and contains also several special papers. One of these is on the Geology of Cape Ann; one on the Geology of Northwestern Colorado, including also the adjacent parts of Utah and Wyoming; one on the Formations by the Vegetation of Hot Springs, and the fourth on the Charleston Earthquake of 1886. The last named, which takes up 328 pages of the report, is accompanied by numerous illustrations, and is an exhaustive account of the phenomena observed in connection with the earthquake not only in and near Charleston, but throughout the country. It is a very interesting monograph.

The administrative reports give a fair idea of the amount of work accomplished by the Survey during the year, and the extent of country covered by its investigations. The topographic surveys covered an area of 52,062 square miles, while the geologic work was prosecuted on the Atlantic Coast, in the Northeast, in the Lake Superior District, in the Appalachian Mountain Region, in Colorado, in the Yellowstone Park, and on the Pacific Coast. The collection of mining and mineral statistics is also an important branch of the work, the results of which were published some time ago.

THE CIVIL ENGINEER'S POCKET BOOK: by John C. Trautwine, C.E. *Fifteenth Edition, Revised.* 866 pages, illustrated. (New York; John Wiley & Sons.)

Trautwine's Pocket Book has become so much of a standard and so indispensable to engineers since its first publication, in 1876, that it is not necessary to refer at any length here to its contents, or to attempt any criticism. It was revised in 1885, when the ninth edition was issued, and further changes have been made from time to time. In the present or fifteenth edition the principal features are a greatly enlarged article on Weirs, with suggestions for small measuring weirs, and a new article on Centrifugal Force. Minor changes have also been made in a number of other places in the way of correction or the addition of new information.

It is apparent that not much further addition can be made without departing from the form of a pocket book. It is already almost too large, and yet for the purpose for which it is intended it is difficult to see how anything could be omitted and still leave it the general hand-book of condensed information which it now is.

GEOLOGICAL SURVEY OF NEW JERSEY: FINAL REPORT. *Volume II, Part 2: Mineralogy, Botany, Zoology.* (Trenton, N. J.; State Printers.)

This is the third volume of the Final Report of the Geological Survey of New Jersey, a work which stands among the best and most thoroughly executed of any of its kind undertaken in this country. This part is taken up by a catalogue of the insects, animals, birds, fishes, and reptiles found in the State, with brief accounts of the various species and the localities where

they are to be looked for. Necessarily its interest is rather for the student than the general reader, and it would be somewhat presumptuous to attempt to criticise it without long and careful study. It is sufficient to say that the work has evidently been carefully and thoroughly done. That 822 pages should be required for the catalogue will surprise most people, for no one who is not a careful observer of such matters will appreciate the infinite variety of animal life to be found even in a small State, especially where the surface is of so varied a character as is presented by New Jersey.

It is interesting to note that the larger wild animals have almost disappeared from the State. The panther and wolf are known only by tradition; the bear and even the wild-cat are exceedingly rare, while deer, once abundant, are now only occasionally found. In a State so thickly settled as New Jersey there is little chance for any wild animals too large to conceal themselves readily.

The report bears the signature of the late Professor George H. Cook, who organized the Geological Survey and conducted it until his death with much ability. The present volume, however, has been completed and issued under the charge of Professor Cook's assistant and successor, Mr. Irving S. Upson.

PERMANENT FORTIFICATION FOR ENGLISH ENGINEERS: by Major J. F. Lewis, R.E. (323 pages, 43 plates). (Chatham, England; published for the Royal Engineers' Institute.)

"This book is written to save engineer officers trouble," is the opening sentence of the work, and it clearly explains the purpose for which it was prepared. It gives in a permanent form the practical information regarding the construction of batteries, magazines, and the mounting of guns, as practised in the English service, which an officer detailed upon such work might not otherwise have at hand.

Aside from the purely technical information contained in the book, something of interest to the general reader will be found in the fairly good idea it gives of English sea-coast defense. It is interesting to note the manner in which the English engineer has met the problem of preparing masonry fortifications to resist the attack of modern artillery. Wrought-iron shields for guns and fronts for batteries were applied some years ago to all their important works. It is now proposed to increase the thickness of metal as thus applied, and, in addition, to support it with heavy cast-iron blocks, after the pattern of Grüson armor. Protection of open batteries against vertical fire is to be secured by preparing them for a temporary cover of iron or timber, or both, in time of war.

BIBLIOTHECA POLYTECHNICA. *Directory of Technical Literature: A Classified Catalogue of all Books, Annuals, and Journals published in America, England, France and Germany.* Edited by Fritz von Szczepanski. (St. Petersburg; Fritz von Szczepanski, and New York; the International News Company, price, 75 cents.)

Such a catalogue as is proposed in the title of this book is no light undertaking, and its execution must have cost a large amount of labor. As to its completeness one can only judge after using the book some time; at present all that can be said is that it presents a very large number of titles, arranged carefully under appropriate heads. The titles of the various divisions are printed in English, French, and German; those of the books and journals in the language in which they are printed. The name of the publisher, the place of publication, and the price are appended.

It is to be regretted that the publisher did not adopt a somewhat larger type, even at the risk of making a more bulky book. The type used is somewhat trying to the eye. Fortunately the press-work is good and the pages clearly printed.

The book cannot fail to be useful to the student of technical literature, and may often save him a tedious search for works on some special subject.

THE NEW YORK AND BROOKLYN BRIDGE: *Plans of the Rapid Transit Cable Company for System and Terminals:* by A. Bryson, Jr., C.E. (New York; issued by the Rapid Transit Cable Company.)

Mr. Bryson's pamphlet is an addition to the already voluminous literature on the Brooklyn Bridge. It is devoted to a statement of the plan which he has worked out for arranging the terminals and operating the road in such a way as largely to increase its carrying capacity. It is fully illustrated by plans and drawings.

This plan, it is claimed, will not only improve the speed of trains and diminish the chances of accident, but it will shorten the time now required at the terminal stations and will do away with the use of locomotives for switching trains. The arrangement proposed consists of three circular loop tracks at the terminus, around which trains can be run without stopping or reversing their motion; some improvements in grip and details of working the cable are also included.

MECHANICS OF ENGINEERING AND OF MACHINERY; by Dr. Julius Weisbach. *Volume III, Part I, Section II: Mechanics of the Machinery of Transmission. Second Edition, Revised and Enlarged,* by Professor Gustav Herrmann. Translated by Professor J. F. Klein, D.E. (New York; John Wiley & Sons, 550 pages, price, $5.)

This volume is a small part of the new edition of Weisbach's great work, which is now being published in Germany, and on which the editor has been engaged for a number of years. The present section includes nine chapters: Ropes and Chains; Screws; Crank Trains; Cam Trains; Engaging and Disengaging Gear; Regulators. There is also an appendix on the Graphical Statics of Mechanisms.

The translation appears to be a very faithful one, and the engravings are the same as those used in the German edition.

The value of Dr. Weisbach's work is well known to those engineers who believe in his methods of treating the subject, and do not need criticism here. Where mathematical treatment and analysis are wanted his book is unquestionably very high authority, and no one will dispute its excellence.

The engravings are clear, but not by any means fine. They have had the advantage of good paper and careful press-work, for the mechanical execution of the volume is excellent.

THE MECHANICS' COMPLETE LIBRARY: *Modern Rules, Facts, Processes, etc., etc. For Engineers, Mechanics, Electricians, etc.* Compiled by Thomas F. Edison, A.M., and Charles J. Westinghouse. (Chicago; Laird & Lee.)

The contents of this book may be described by one word—hash; or perhaps this is not comprehensive enough, so that the Spanish term, *olla podrida*—which the dictionary says is "a dish consisting of a mixture of all kinds of meat, chopped fine and stewed with vegetables"—being more comprehensive, is better. In other words, it is a miscellaneous collection of selections, taken, apparently, from books, newspapers, or any other source, without order, classification, or any object, excepting to fill a certain number of pages, which will attract the attention of mechanics of limited education. The materials used in making hash are usually good, bad, and indifferent. The same is true of the contents of the book which is the subject of this notice. This much the reviewer feels bound to say, because he found some of his own productions formed part of the stew. Hash and the book are alike, too, in the fact that the one would be nutritious to a person physically hungry, and the other to those who never have had much intellectual food of this kind. The book, in fact, is hardly worthy of notice, but doubtless will serve a more or less good purpose to those whose mental tether is very short.

TRADE CATALOGUES.

Consolidated Safety Valve Company, 111 Liberty Street, New York.

This is a neat pamphlet, with 57 pages 6½ × 9½ inches in size. It illustrates by engravings and descriptions all the varieties of "Pop" safety valves manufactured by this Company, with the methods of applying and using them. The illustrations, paper, and printing are all good.

The Ashcroft Manufacturing Company, 111 Liberty Street, New York.

This Company makes steam-gauges, gauge-cocks, water-gauges, pipe-tools, low water detectors, furnace doors, oil-testing machines, steam-engine indicators, etc., all of which are well illustrated and described in their catalogue before us. It is of the same size and "get up" as that of the Consolidated Valve Company.

Pedrick & Ayer, Philadelphia.

Like all the printed matter emanating from this establishment, their new catalogue is unsurpassed in what may be called its mechanical fabrication. Its paper, typography, engraving, border-lines, corner ornaments, are all in good taste. The book is bound in paper, has 66 pages 9½ × 12½ inches in size. Each page has a light gray tint over the surface occupied by the letterpress, which makes it very pleasant to the eye in reading. Our criticism is that the pages are too large, which makes the volume inconvenient to store and handle. This is noticeable, because all the engravings would go on a page half as large.

The illustrations and descriptions are of the machines made by this Company, consisting of Milling Machines, the methods and purposes for which these are used; Cylinder Boring and Facing Machines, Duplex Boring Machines, Portable Boring Machines, Universal Grinding Machines, Richard's Patent Open-Side Planing and Shaping Machines. These are all beautifully illustrated.

Catalogue No. 1. Consolidated Car-Heating Company, Albany, N. Y.

The consolidated Car-Heating Company announce in this catalogue that they have succeeded to the business and own the patents formerly the property of the Sewall Car-Heating Company, the McElroy Car-Heating Company; (Westinghouse) Standard Car-Heating and Ventilating Company; (Murdoch-Peerless) Automatic Car-Heating Company, and, in part, the (Leland) Universal Car-Heating Company, thus controlling some 100 patents covering the whole field of car-heating.

The catalogue before us contains descriptions of the various systems and the apparatus recommended by the Consolidated Company, with details of the various parts to facilitate ordering these separate parts. The book is 7 × 10 in., and contains 114 pages, with over 100 engravings. The catalogue is well printed on good paper, with excellent engravings. The criticism we feel disposed to make on it is that it contains too much of commendation and not enough of elucidation. A volume of this kind ought to be an elementary treatise on the subject to which it relates. To some extent the catalogue before us is a treatise, but if it explained the apparatus for car heating more fully, the volume would be more useful to many readers. As catalogues go, it is an excellent one.

Schoen Manufacturing Company, Pittsburgh, Pa.

This Company make various articles used in car construction out of pressed steel. Among these are stake pockets, center-plates, draw-bar attachments, corner bands, dead-blocks, bolster guide-bar columns and plates, brake-beams, etc. These are all described in their catalogue and illustrated with suitable engravings.

In the introduction to their catalogue, Messrs. Schoen say that, "By the use of their articles, the weight of the ordinary freight car will be decreased from 800 to 1,200 pounds, the cost of repairs reduced to a minimum, and the appearance of the car greatly improved, all without material increase in cost of construction."

This leads to the reflection of what might be accomplished if some master of design, with sufficient knowledge of car construction, could have an opportunity of designing a freight car with reference to a reduction of dead-weight. Various efforts, it is true, have been made in this direction in years past, but those who have undertaken it have generally been deficient in one or more of the following qualifications—first, theoretical knowledge of the strength and strains on materials, second, capacity for designing, and ingenuity in the adaptation of mechanical means to accomplish required ends, or third, practical and thorough knowledge of car construction. It seems certain that a person with these requisite qualifications might, by using Messrs. Schoen's and other improved devices, greatly reduce the weight of cars without any material increase in cost or decrease in strength or endurance.

Thacher's Calculating Instrument.

This is a small pamphlet issued by Messrs. Keuffel & Esser, of New York, and Mr. Edwin Thacher, of Louisville, Ky., the inventor of the instrument. The pamphlet contains a meager description of the instrument and a large number of testimonials with reference to its usefulness. The instrument, it is said, "consists of decimal scales arranged in parallel lines on the surface of a cylinder and on the inclined sides of triangular bars forming an open framework, within which the cylinder can be revolved or moved back and forth. By these movements any required portion of the scales on the cylinder are brought opposite any required portion of the scales on the bars, and the use of the instrument consists in the setting and reading of these scales, a simple operation readily acquired.

"The object of the instrument is to overcome the drudgery of calculation, and accomplish rapidly by mechanical means otherwise tedious arithmetical solutions. By the use of the instrument the mind is not only greatly relieved, but results are more reliable than when worked out in the usual way. There is less liability to error in the setting and reading of the scales than in ordinary arithmetical processes, but if mistakes should occur the work can be rapidly checked. After becoming once familiar with the instrument, results are obtained with great rapidity; this not only applies to ordinary calculations, but complicated formulas involving powers and roots are worked with equal facility. The useful applications of the instrument are as general as the rules of arithmetic. Examples in multiplication, division, proportions, powers or roots involving not more than three quantities, are solved by one operation, and any number of values of a single variable are found by one setting of the instrument."

BOOKS RECEIVED.

Determination of the Mean Density of the Earth by means of a Pendulum Principle: by J. Wilsing. Translated and Condensed by J. Howard Gore. From the Smithsonian Report for 1888. Washington; Government Printing Office.

First Lessons in Metal Working: by Professor Alfred G. Compton. New York; John Wiley & Sons (price, $1.50).

Valve-Gears: by Passed Assistant Engineer H. W. Spangler, U. S. N. Analysis by the Zeuner Diagram. New York; John Wiley & Sons (176 pages, 106 illustrations; price, $2.50).

Monographs of the United States Geological Survey. Volume I., Lake Bonneville; by Grove Karl Gilbert. Washington; Government Printing Office.

Annual Report of the Commissioner of Patents for the Year 1889. Washington; Government Printing Office.

Annual Report of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce of the United States for the Year Ending June 30, 1890: *S. G. Brock, Chief of Bureau.* Washington; Government Printing Office.

De la Production et l'Emploi de la Vapeur Consideree comme Force Motrice: par MM. Lencauchez et L. Durant. Paris, France; G. Steinheil. This is a reprint in pamphlet form of a paper prepared for the Société des Ingenieurs Civils at Paris.

Les Avantages de la Haute Pression de la Vapeur dans les Machine Compounds: par M. A. Lencauchez. Paris, France; published by the Author. Like the preceding, this is a reprint from the proceedings of the Société des Ingenieurs Civils.

A Comparison of the Ball Automatic Cut-off Gear and the Stephenson Link Motion: by Harry P. Jones, M. E. Portsmouth, N. H.; published for the Author. This is a reprint of a paper presented at the Indianapolis meeting of the American Association for the Advancement of Science, and subsequently published in the *Stevens Indicator.*

Prospectus of the National Electric Light Association. New York; issued by the Association.

Bulletins of the United States Geological Survey; Nos. 58,59, 60, 61, 63, 64 *and* 66. Washington, Government Printing Office.

The Metric System: Detailed Information as to Laws, Practice, etc. New York; the American Metrological Society.

Columbia Cycle Calendar for 1891. Boston; the Pope Manufacturing Company. This is an exceedingly convenient calendar for the desk.

How to Bore a True Hole: Waterman's Book about Nicholson's Horizontal Borer. Providence, R. I.; the Nicholson & Waterman Manufacturing Company.

Municipal Lighting: by M. J. Francisco. With Appendix: Correspondence with John P. Barrett, of Chicago. New York; published by order of the National Electric Light Association.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department. Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending June 30, 1890: *S. G. Brock, Chief of Bureau.* Washington; Government Printing Office.

Transactions of the Canadian Society of Civil Engineers: Volume III, January—December, 1889. Montreal; printed for the Society.

ABOUT BOOKS AND PERIODICALS.

AMONG the articles in BELFORD'S MAGAZINE for December is one by E. F. Boyd on the Power of the United States, which contains some predictions as to the future growth of the country in population. An article on the *Merrimac* and the *Monitor,* by J. L. Le Faucheur, gives the often-told story of the first fight of iron-clads from a Confederate point of view. Military readers will be interested in the two articles by Generals Longstreet and Trumbull sharply criticising Lord Wolseley's work as a military critic. This magazine has its own opinions on current topics, and does not hesitate to express them in a very emphatic and readable way.

The large number of readers who wish to know something of foreign magazine literature, but have not time or opportunity to read the foreign periodicals, should be grateful to the ECLECTIC MAGAZINE for the judicious selection which it presents each month. A striking article in the December number is an appreciative review, from *Blackwood's Magazine,* of Captain Mahan's "Influence of Sea Power on History"—a remarkable book, by an American naval officer of high standing.

The December number of SCRIBNER'S MAGAZINE is a Christmas number, and is given up chiefly to holiday literature of the lighter kind. It contains the first of Sir Edwin Arnold's papers on Japan, which is a general description of the country, and is apparently a preliminary or introductory paper for the series which will follow it.

With the December number the ARENA begins its second year, and it may be said that in its first this magazine has fairly earned success. As a field for the full and free discussion of social and economic questions of current interest its name is well chosen, and it has made for itself a recognized position which no other magazine holds or has held heretofore. That this is no easy thing for a new periodical to do hardly needs to be said, but in this case the place has been secured by meriting it.

Like some of the other magazines, HARPER'S for December is a holiday number, and is chiefly given over to lighter literature. Mr. Charles Dudley Warner's sketches of Southern California are continued in this number, picturing a very attractive country, with a solid basis for continued growth in its natural advantages and resources.

In the POPULAR SCIENCE MONTHLY for December an illustrated article on Early Steps in Iron Making, by W. F. Durfee, is the first of a series of articles on the Development of American Industries since Columbus. These will include all the prominent branches of manufacture, and will be written by experts in the several branches. Mr. Barr Ferree writes in this number on Architecture and its Environment. A striking article on the Identity of Light and Electricity is by Professor Henri Hertz.

The reader who is interested in outdoor sports of all kinds will find OUTING for December an excellent winter number. As usual with this magazine also, no inconsiderable amount of information on travel and geography can be found in its columns for the month.

A number largely historical is presented by the OVERLAND MONTHLY for December. General John Bidwell contributes some interesting reminiscences of the Conquest of California, and Mr. Willard B. Farwell concludes his paper on the much disputed question of Fremont's Place in California History. Eastern Oregon finds its place in a short but comprehensive article. Those who like to read of the less known parts of the earth will find much information in a paper on Borneo and Labuan, by a writer whose name is not given.

M. Mallet, the well-known French engineer, has issued in pamphlet form a paper prepared by him for the Société des Ingenieurs Civils at Paris on the Development of the Application of the Compound System to Locomotives. It is an interesting study on the subject, and is illustrated by a number of diagrams.

The latest quarterly number of the JOURNAL of the American Society of Naval Engineers contains articles on the Graphic Method for Determining and Counterbalancing the Centrifugal Action of the Connecting-Rod, by Passed Assistant Engineer A. B. Canaga; the Ericsson Compound Engine and Belleville Boiler, by Chief Engineer B. F. Isherwood; New Forms of Evaporators, by Passed Assistant Engineer G. W. Baird; Analysis of Engine Trials, by Assistant Engineer W. H. Allderdice; Trial of the *Philadelphia,* by Assistant Engineer W. H. Chambers; Trial of the *San Francisco,* by Passed Assistant Engineer E. T. Warburton. There are also a number of interesting short notes on current topics, and a continuation of the discussion on Tubulous Boilers.

THE NEW GEODETIC SURVEY OF FRANCE.

(Condensed from *Le Genie Civil.*)

A GENERAL geodetic survey of France was projected some time ago, and was begun under the direction of M. Bourdaloue in 1857, but was abandoned in 1864, after the base-lines only were completed.

The new general survey was begun in 1884 and is now in progress; it comprises:

1. A new system of base-lines, in all about 7,500 miles long. These generally follow the main lines of railroad, the easy grades of which permit very accurate leveling and measurement.

2. Subordinate detail lines, including about 500,000 miles in all.

3. A system of contour lines extending over all French territory.

The new base-lines will also be made to serve to connect the geodetic survey of France with those of neighboring countries, and to compare the mean levels of the Mediterranean, the Atlantic and the English Channel.

The cost is estimated at about $4,000,000. The work is under the direction of M. Lallemand, who has very fully described its progress and methods in a work—Traite de Nivellement de Haute Precision—recently published.

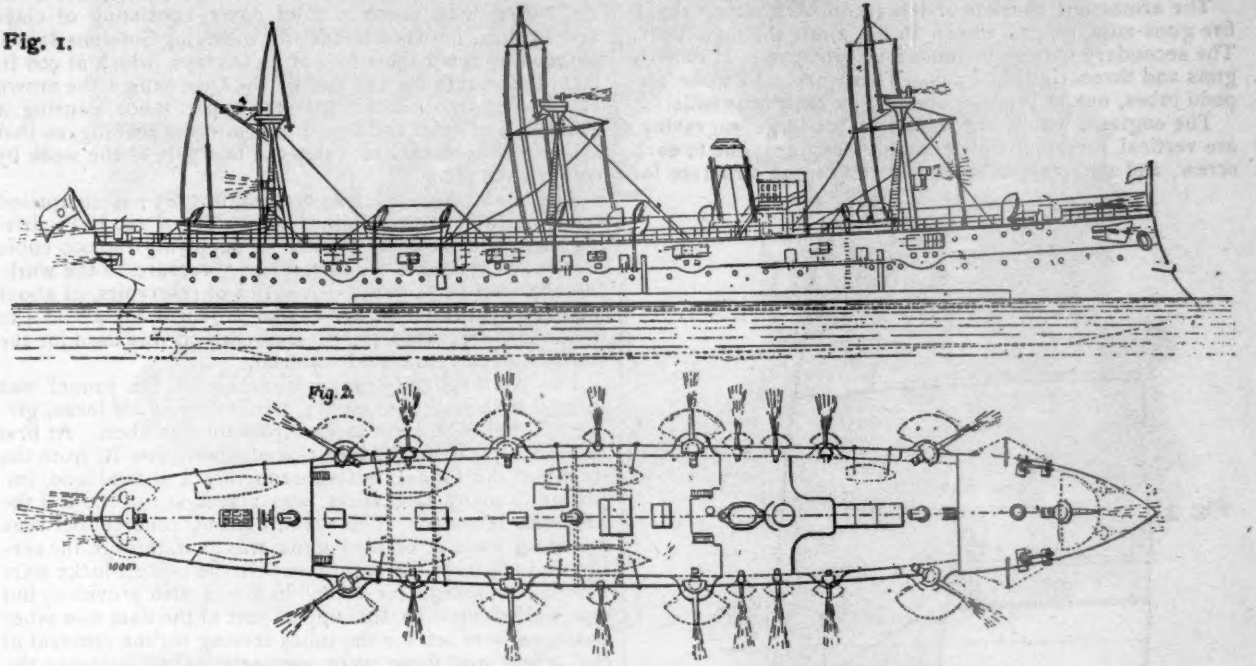
The base-lines consist of closed polygons, averaging about 380 miles in perimeter. Fixed bench-marks are placed 500 to 1,000 yards apart. Each section between two bench-marks is leveled in both directions, and one day's work is confined to each section. All reductions and calculations are made at a central office. The bench-marks are of oxidised iron or bronze, and built into the walls of solid buildings. They enclose a tablet describing their position in the survey and the level.

The level used is carried on a spherical bearing, which permits the telescope to be rapidly placed approximately level without moving the legs. By means of reflecting prisms the two ends of the bubble-glass are visible to an observer standing at the eye-piece of the telescope, so that he can verify the accuracy of his adjustment at any moment without leaving his post.

The staff used is the compensating staff of Colonel Goulier, which contains a double metallic rule of iron and brass, by which the variation in length of the graduations on the wooden staff can at any moment be observed. This variation is observed three times a day by the leveler, and amounts to some thousandths per cent., having a daily and also a yearly period, and varying from one staff to another. The divisions are in centimeters, 5 millimeters and 2 millimeters. These divisions are not accurately equal, a systematically erroneous division being preferred, in which the law of error is only known at the central office, as thus it becomes more difficult for the operators to attempt to correct any observations the results of which do not sufficiently agree.

About two-thirds of the base-lines are now leveled, and this first part of the work will be finished before three years. The probable error amounts, on the average, to less than 0.9 millimeter for a distance of 1 kilometer (about 0.57 in. per mile), while in the operations of Bourdaloue it amounted to from 2 to 3 millimeters per kilometer (0.13 to 0.19 in. per mile). The probable error from Marseilles to Lille does not exceed 2 in. The datum level is the mean sea-level at Marseilles, and a new tidal gauge has been established there, in order to determine the datum anew with great accuracy.

Fig. 1.



THE NEW CRUISER "CHIYODA," FOR THE JAPANESE NAVY.

A JAPANESE CRUISER.

THE accompanying illustrations, which are from London *Engineering*, show the new cruiser *Chiyoda*, built by the firm of J. & G. Thompson, Glasgow, Scotland, for the Japanese Government. The *Chiyoda* is intended for a fast cruiser carrying a heavy battery of rapid-fire guns, and was designed in the Japanese Navy Department, although some changes have been made in accordance with the advice of the contractors. It is expected that her speed will reach 19 knots an hour under forced draft.

The principal dimensions are: Length, 310 ft.; breadth, 42 ft.; depth, 23 ft. 8 in.; mean draft, 14 ft.; displacement, 2,450 tons.

In the illustrations, fig. 1 is a profile view; fig. 2 a deck plan; fig. 3 a partial cross section, showing the means adopted for protection. The large engravings give two views of the engines.

As shown in figs. 1 and 3 the water-line for two-thirds of its length will be protected by a belt of 4-in. steel plate bolted on the outside of the shell, and extending for about two-thirds the length of the ship. The machinery and magazines are protected by a steel deck extending the whole length of the ship, and having an average thickness of 1 in. This deck is made in two layers, the lower of ordinary steel and the upper of chrome steel. The space between the protective deck and the ordinary deck will be

filled with coal, as shown in fig. 3, and the arrangement of the coal bunkers on the sides of the ship will also serve for additional protection. A belt of celluloid is placed back of the armor-belt and also back of the coal bunkers and over the engines, as shown in fig. 3.

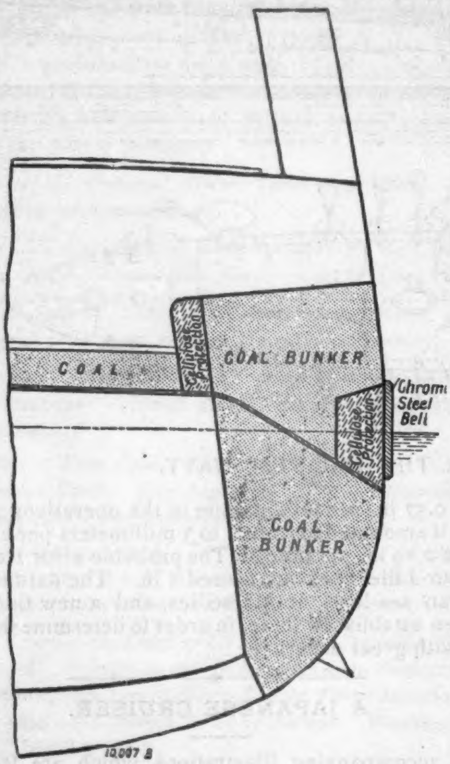
The ship is lighted throughout by electricity, and has powerful search-lights, one forward and one aft. She carries three masts, each having a military top containing a Gatling gun. The vessel has a double bottom, and is divided into numerous compartments.

In order to provide for good manœuvring power, a patent balanced rudder has been fitted, on the principle already adopted in the *Reina Regente* and other war vessels.

The armament consists of ten 4.7-in. Armstrong rapid-fire guns mounted, as shown in fig. 2, on the main deck. The secondary battery includes fourteen 47-mm. Hotchkiss guns and three Gatling guns. There are also three torpedo tubes, one at the bow and one on each broadside.

The engines, which are shown in the large engraving, are vertical, inverted triple-expansion engines, one to each screw, and are arranged so as to give a strong structure for

Fig. 3



the minimum of weight, and at the same time to make all the working parts easily accessible. The cylinders are supported by steel columns bolted to a cast steel bed plate. The cylinders are 26½ in., 39 in. and 57 in. in diameter, with 27 in. stroke. They are all fitted with piston-valves, worked as shown in the engraving from eccentrics placed on the main shaft, driving links. The air-pumps are worked from the low-pressure crosshead. When running at full speed these engines will make 230 revolutions per minute.

Steam is supplied by six locomotive boilers placed in two separate water-tight compartments forward of the engines. The boilers are of steel, and are 7 ft. in diameter and 18 ft. long, each having two fire-boxes. Forced draft is applied on the closed stokehold system. There are four fans 60 in. in diameter and intended to make 250 revolutions per minute. Each fan is driven by a direct-acting single cylinder engine.

The coal capacity is about 700 tons. At a speed of 10 knots per hour the cruising range is estimated at 8,500 knots.

The *Chiyoda* was launched in June last, and is now being completed for delivery to the Japanese Government.

THE BRAYE TUNNEL.

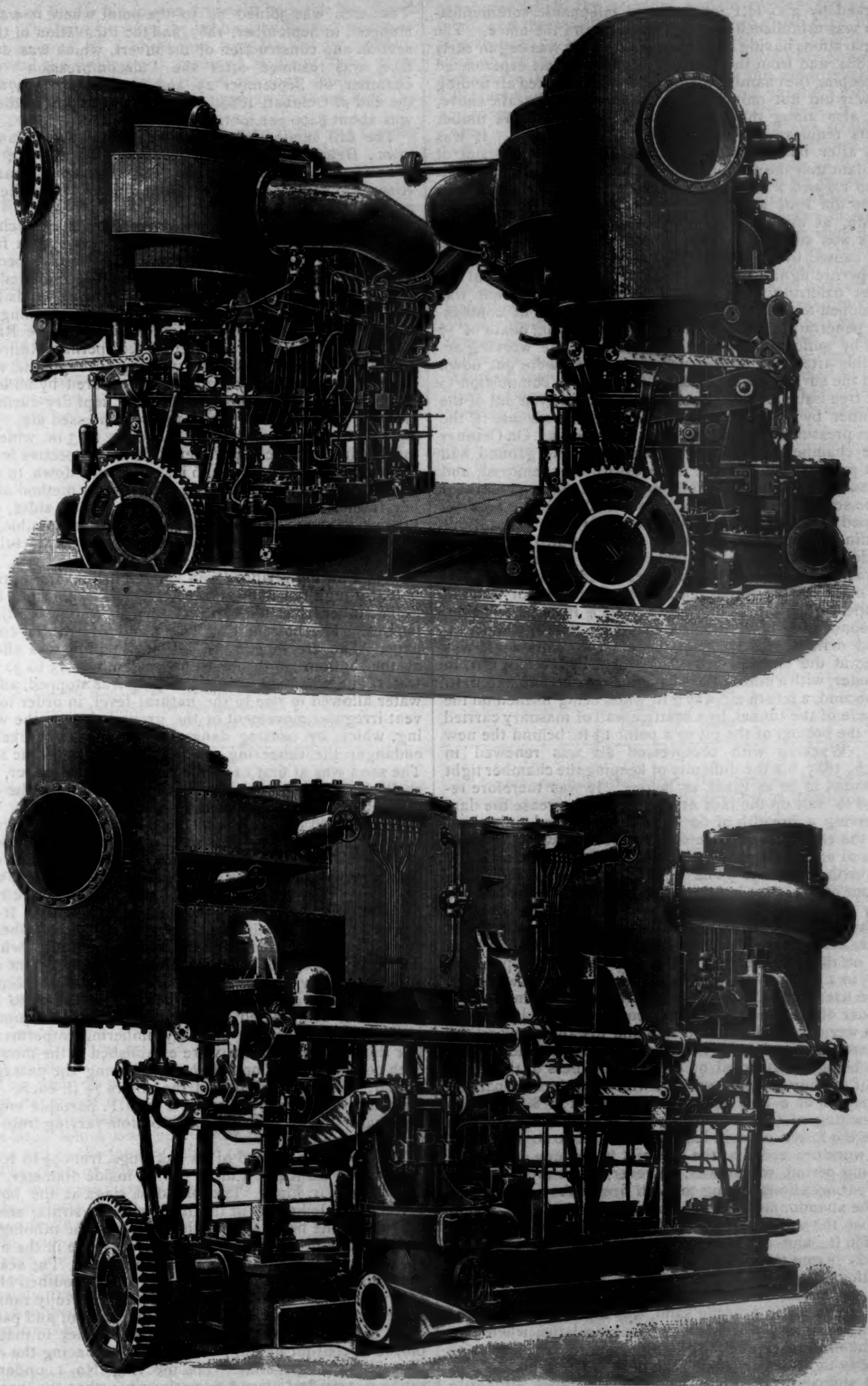
(Papers of the Institution of Civil Engineers.)

THE summit dividing the basins of the Oise and Aisne, in France, on the navigable canal in course of construction between these rivers, is passed by a tunnel 7,740 ft. long, at a depth of 400 ft. below the crest of a ridge, which is made up of alternations of sands and clays capped by the *Calcaire Grossier*, the whole being of eocene tertiary age. The stratification, which is regular in the higher parts, is subjected to a disturbance at the base, so that the tunnel, which should be entirely in the lower sand, *Sable de Bracheux*, with about 40 ft. of cover, consisting of clays and lignites, between it and the overlying Soissons sands, passes through a short fold of these clays, which at 900 ft. from the mouth on the side of the Oise brings the crown of the roof into contact with the upper sands, causing a great flow of sand and liquid clay into the heading, so that it became necessary to carry out this part of the work by compressed air.

The plant required was erected in 1883; it comprised seven portable steam-engines, altogether of 220 H.P., driving eight compressors, capable of supplying 180,000 cubic feet of air, at double the atmospheric pressure, to the working chamber in 24 hours. A series of reservoirs, of about 3,000 cu. ft. capacity, were also provided for air at 4 to 6 atmospheres absolute pressure, which was used for the removal of the excavated material.

The working chamber at the face of the tunnel was formed by a wall of masonry, perforated by air-locks, giving admission and exit to and from the chamber. At first this wall, 11 ft. thick, was placed about 400 ft. from the mouth of the tunnel, but subsequently a second one, improved in many particulars, was placed at 614 ft., and the first was removed. This dam, built of concrete between retaining walls of dressed stone, was 22 ft. thick in the center, and 26¼ ft. at the bottom, where the two air-locks were placed; a passage for a third lock was also provided, but was walled up. In the upper part of the dam two other passages were left for the tubes serving for the removal of the débris, and these were similarly walled up when the tubes were erected.

The air-locks were of the section of ordinary mining-galleries, 26¼ ft. long, 5 ft. 5 in. broad, and 7 ft. 3 in. high, or sufficiently large to allow the passage of mine-wagons. They were provided with a sheet-iron lining, built up in rings, bolted together with india-rubber washers, and air-tight doors closing against seats faced with india-rubber, opening inward—that is, from the outer air to the lock, and from the latter into the working chamber. At first the doors were closed by screws, but these were inconvenient on account of the slowness in manipulation, and rack and pinion movements, governed by levers, were substituted. The pressure of the air released the lever, which was then lowered shortly after use, so that the door was only kept closed by the difference of pressure on the two sides and in the levels. They opened of themselves as soon as the two sides were in equilibrium. The outer door had only a single lever worked from within the lock, while the inner one had one on each side, so that it could be worked either from within or without the chamber. The low-pressure air was introduced by four pipes placed close to one of the walls, and that at high-pressure, for the removal of spoil and water, by a fifth near the bottom. Two 16½-in. pipes were passed through the upper arches, and two of 13¾ in. through the bottom of the wall, both series being provided with stop-valves at the ends. The larger pipes inclined outward, and were turned up to a vertical position within the chamber. When required for use the inside valve was opened, the tube filled with spoil and closed again. At a given signal the outer valve was opened, at the same time as that connecting the tube with the high-pressure main containing air of at least four atmospheres pressure, which cleared out the contents in a few seconds. The outer valve was then closed and the filling repeated as before. In the same way the water accumulating in the bottom of the chamber was driven out by connecting the lower tubes with the high-pressure air service. The working chamber was lighted by Edison glow lamps and a Gramme dynamo



TRIPLE EXPANSION ENGINES FOR JAPANESE CRUISER "CHIYODA."

worked by a 15 H.P. engine, and telephonic communication was established between the face and the office. The preparations having been completed, work was begun early in 1884, and from the first great difficulty was experienced in keeping the chamber air-tight, the compressed air finding its way out not only through the penetrable strata above, but also along the extrados of the roof and the timber struts required for the support of the ground. It was only after building 20-in. buttress-rings on either side of the dam that the pressure on the chamber could be brought up to 1.8 and 2 atmospheres (absolute), under which condition the roof was completed to about 660 ft. from the mouth, at the rate of 39 to 48 ft. per month, when the work was stopped by an accident in August, 1884. This was caused by the compressed air getting into the overlying pyritic lignite-bearing strata, and after driving out the water oxidizing the pyrites, whereby sufficient heat was developed to fire the lignite, and the products of combustion penetrating to the chamber caused the death of 17 men by suffocation. In order to render the working accessible after this accident six bore holes were put down from the surface to the seat of most active combustion to give free issue for the gases, which were driven out of the chamber by projecting highly compressed air into it, the mean pressure being kept at 1.6 atmospheres. On October 4 the chamber was accessible, and after the ground had been properly shored up, the pressure was removed, and the surface water being no longer kept back, penetrated to the seat of the fire and extinguished it; but the heat developed was sufficient to keep the temperature of the water trickling through the roof at 90° for six months. After the accident the first dam was removed, and the second at 614 ft. was erected, as previously described. Provision was also made for the active ventilation of the part of the tunnel open to the air, by sinking a shaft a little on one side, and connecting it with the crown of the arch by a short inclined drift at 358 ft. from the mouth. This shaft was closed at the top and provided with a Pelzer fan, 6 ft. in diameter, with a minimum exhausting capacity of 500 cu. ft. per second, a return air-way 6 ft. wide, being formed on the left side of the tunnel, by a brattice wall of masonry carried from the bottom of the pit to a point 13 ft. behind the new dam. Working with compressed air was renewed in March, 1885, but the difficulty of keeping the chamber tight was found to be as great as before. It was therefore resolved to wall up the face at 820 ft., and increase the dam by leaving a breadth of 60 or 70 ft. of ground unbroken, with the exception of three small galleries, two at the bottom and one at the crown of the arch, which were carefully lined with masonry. The upper one proved a failure on account of the large leakage at its mouth, and was blocked up by a 39-in. wall, after a length of 85 ft. had been driven; but the lower ones being driven in compact clay, succeeded better, and remained perfectly tight when 33 ft. had been lined on the left side and 79 ft. on the right. A pressure of 2.3 to 2.4 atmospheres was then kept up in the workings by the use of two-thirds of the motive power during the remainder of the time that it was required. The lower galleries were carried forward to some distance beyond the dangerous ground at 983 ft. from the mouth, their outer walls being constructed of the full thickness of the lower part of the finished side walls of which they formed part up to a height of 8 ft. 8 in., a further height of 8 ft. 4 in. to the opening of the arch being put in by galleries driven above the lower ones in lengths of about 70 ft. at a time. This work proceeded at the rate of 5 ft. per day during the working period, which was, however, interrupted on four different occasions, owing to fresh fires in the lignite, causing the abandonment of the work for a time.

When the walls were finished to 1,302 ft., a rise was put at 1,286 ft., and a length of 13 ft. of the arch was completed. From this point the work was carried on in both directions, but principally backward, at the rate of about 40 ft. per month of actual work. The crown of the arch, although partly in running sand, was kept sufficiently tight by timbering and closely driven packing laths, when care was taken to insert the latter singly, and to drive each one perfectly tight before placing the next. The sand was rendered sufficiently coherent by the compressed air not to run as long as only a small surface was exposed at a time. The arch was joined up to the point where it was first stopped, in September, 1887, and the excavation of the full section and construction of the invert, which was done in face, was resumed after the "decompression" of the chamber, on September 25, and completed to 1,476 ft. at the end of October, 1888. The cost of this part of the work was about $400 per foot.

The full section of the finished tunnel inside is as follows: Height, 28 ft.; width at bottom, 24 ft. 7 in.; width at spring of arch, 26 ft. 3 in. The extension toward the Aisne Valley was carried on from shafts sunk in the manner described below.

The middle section of the Braye Tunnel is reached by two shafts known as Nos. 2 and 3, respectively 301 ft. and 378 ft. deep, and distant 3,543 ft. and 5,166 ft. respectively from the mouth on the Aisne side, which necessitated passing through from 40 to 70 ft. of the Soissons sands below the water-level. The method adopted for sinking was similar to that formerly applied in making the Rilly la Montagne tunnel on the Reims & Epernay Railroad—namely, the use of cast-iron tubbing through the water-bearing bed, which was afterward secured by underpinning with oak cribs, the ground being kept dry during the erection of the latter by the use of compressed air.

The shafts, rectangular in section, 5 ft. 3 in. wide, and divided into three compartments, of the respective lengths of 5 ft. 7 in., 5 ft. and 3 ft. 6 in., were put down to about 30 ft. below the water-level by the ordinary method of timber frames, 40 in. apart, and close boarded sides, when further progress by this means became impossible, and cast-iron tubbing was substituted. A separate tubbing was used for each compartment. The rings, 1.2 in. thick and 39.4 in. high, ribbed and flanged inside, are united by bolts through the flanges, the joint being kept tight by an india-rubber ring filling seats turned into the adjacent flanges. The bottom ring was provided with a cutting edge. The erection of the tubbing-column was effected at the bottom of the shaft in a depth of 25 to 30 ft. of water, and when completed pumping was stopped, and the water allowed to rise to the natural level, in order to prevent irregular movement of the ground during the working, which, by causing dangerous hollows, was likely to endanger the timbering of the upper part of the shaft. The sand was at first excavated by a bucket-dredger, then shell augers were used, but finally divers filling the sand directly into tubs were found to be most expeditious. The diver removed the sand at the bottom of the compartment, but without uncovering the cutting edge of the tubbing; the column was then forced down by hydraulic jacks of 20 tons power, until a depth of 20 to 40 in. was attained, when the sand was again cleared out, and so on, the work being done alternately in the different compartments. It was hoped that a tight joint would have been obtained when the cutting-ring had penetrated the clay below, but, owing to the small breadth of the ribs dividing the different compartments, they gave way, and allowed the sand to penetrate from above. It therefore became necessary to have recourse to compressed air in order to render the junction of the tubbing with the ordinary timbering impermeable. For this purpose airlocks were established at the mouth of each compartment; one of these, allowing the passage of timber, was 16½ ft. high, and the others 7½ ft. each. The air-compressor was driven by a 15-H.P. portable engine, and maintained a pressure in the bottom varying from 2.35 to 2.8 atmospheres.

The joint was formed of six oak rings, from 9½ to 10½ in. square, and from 4 ft. 4 in. to 6 ft. in inside diameter, built into a pile 5 ft. high. The broadest rings at the bottom resting on a ledge cut in the impermeable strata, and the narrowest one bears against the bottom of the tubbing, the cutting edge of the shoe resting in a groove in the upper surface containing an india-rubber washer. The seat for these rings was made by excavating a bell-mouthed chamber, which was filled up with concrete carefully rammed after the rings had been placed in position, and packed with moss and wedged in a similar manner to that employed in coal-pit sinking. The order of placing the rings was somewhat peculiar. The top ring, No. 1, under the tubbing, was first placed provisionally; then the broader ones, Nos. 6 to 3, were built up, and the hollow behind con-

creted, and finally No. 2 was driven in between No. 3 and No. 1. The joint between the tubbing and No. 1 ring was further secured by a sheet-iron ring backed by cement. Afterward the sinking was resumed at the ordinary pressure, and secured by close cribs of oak for a depth of 6 ft., below which ordinary frames 40 in. apart are used as in the upper part.

The cost of these appliances to the two shafts was $55,080 for a depth of 161 ft. 9 in., or about $340 per foot.

TESTS OF SOME ARKANSAS SYENITES.

By J. Francis Williams, C.E., Ph.D.

(Published by permission of the director of the Geological Survey of Arkansas.)

THE following tests were made for the Geological Survey of Arkansas, with a view of determining the fitness for building stone, as far as strength and absorptiveness is concerned, of the syenites found in the State.

The syenites of Arkansas are grouped into three regions, and are known as the Fourche Mountain or Little Rock, the Saline County and the Magnet Cove syenites. The first of these groups forms the Fourche Mountain, a few miles south of Little Rock, and contains the so-called "Blue Granite," which is an elæolitic augite hornblend syenite, and some "Gray Granite," which is a light gray, coarse-grained, elæolite syenite. The "Blue Granite" has already become a very important building stone, and many edifices, both in Little Rock and elsewhere, have been constructed of it. It is also much used in making the Belgian blocks so extensively employed in paving. The "Gray Granite" has been worked to some extent for trimmings and ornamental stone.

The Saline County region contains almost exclusively elæolite syenite of a reddish or grayish color, but it has as yet found only a very limited market, on account of its distance from the railroad, which is, however, only about four miles.

The rock of the third region is for the most part an elæolite augite syenite, and has been quarried at two points. It was formerly used in making millstones, and has lately found some application in building railroad culverts and in the foundations of houses.

The tests, of which the results are given below, were made in the mechanical laboratory of the Rensselaer Polytechnic Institute, at Troy, N. Y., on a 50,000-lb. Tinius Olsen testing machine. The specimens were cubical in form, and were cushioned with pieces of book-binders' board* about $\frac{3}{16}$ in. in thickness. The cubes were cut by Peter Grant, of Troy, N. Y., from larger blocks taken directly from the quarries, and were finished down to sand-rubbed surfaces. These specimens were carefully measured with a micrometer measuring apparatus. The area over which the pressure was distributed was calculated, and the weight found necessary to crush each block was reduced to pounds per square inch. In the fifth column of the table given herewith are placed the pressures per square inch, which were found by the experiments recalculated by means of Gillmore's* cubic parabola formula to corresponding pressures per square inch in 2-in. cubes. The rock showed no bedding nor false stratification in any direction, so that those faces which were most perfect and most nearly parallel were chosen as those to which to apply the pressure. The specimens broke suddenly with an explosive force, and in some cases the small pieces tore the heavy binders' board completely to pieces.

The specific gravity and ratio of absorption were determined by following the methods suggested by Gillmore† and Merrill‡ respectively, as follows: Small, irregular pieces of stone weighing from one to three ounces were smoothed until they presented no sharp corners nor rough edges; these were next accurately weighed (A) and then immersed in water and allowed to soak for 24 hours. After the expiration of that length of time they were weighed suspended § in water at 60° Fahrenheit (B), and then weighed again after having been quickly dried externally (C). When the various weighings are represented by letters, as indicated above, the formulæ for the ratio of absorption and specific gravity become as follows:

No.	Description of Specimen.	County, where Found.	Area of Surface in square ins.	Actual Crushing Load.	Pressure per square inch.	Reduced to correspond to pressure per square inch in 2-in. cubes.	Ratio of Absorption—1 to :—	Specific Gravity at 60° F.
1	Light colored elæolite syenite, slightly decomposed......	Saline.	2.34	48,000	20,500	22,350	761	2.62
2	"Gray Granite," a very light-colored elæolite syenite...	Pulaski.	2.25	33,750	14,000	16,000	83	2.45
3	Brownish elæolite porphyry, occurs in narrow dike......	"	1.42	30,000	21,000	24,980	161	2.52
4	"Light-blue Granite" (syenite)......................	"	1.64	47,000	28,700	33,280	....	....
5	" " " (somewhat darker)......	"	1.07	22,800	21,500	26,820	....	....
6	" " " (still darker)............	"	1.57	35,950	22,900	26,745	1,673	2.64
7	"Medium Blue Granite" (syenite)...................	"	1.50	43,500	29,000	34,150	....	....
8	"Dark Blue Granite" (syenite porphyry)...............	"	1.57	43,800	27,900	32,630	4,530	2.69
..	Mean of last five specimens. Average for "BlueGranite."	"	....	....	26,000	30,740	....	....

$$\text{Ratio of absorption} = 1 \text{ to } \left(\frac{A}{C - A}\right).$$

$$\text{Specific gravity} = \frac{A}{A - (B - [C - A])} = \frac{A}{C - B}.$$

The last five specimens represent those rocks which are usually employed in construction, and were taken from the more important quarries on Fourche Mountain; but as there is very little to choose between them, and as it is not at all certain that the specimens were all from equally fresh material, and were subjected to the same amount of jar and strain in dressing, it would be of no real value to give the names of the quarries from which the individual specimens came, and it might lead to discriminations where such are not warranted.

The average pressure per square inch which the blue granite (syenite) stood is remarkably high, and shows that the stone is well fitted for building purposes, and especially for paving blocks. As there is little or no pyrite and magnetite present, it is probable that the rock will long retain its pleasing color, and will form a durable and desirable building stone.

* For a description of the use of these see "Tests of Rutland and Washington County Slates," by J. Francis Williams, *Van Nostrand's Engineering Magazine*, Vol. CLXXXVIII, New York, 1884, p. 101.

* Q. A. Gillmore: Report on the Compressive Strength, etc., of the building stones of the United States in most general use. Appendix II of the Annual Report of the Chief of Engineers for 1875. Washington, 1875, pp 19. and 20.

† Q. A. Gillmore, l.c., p. 7.

‡ Annual Report of the Board of Regents of the Smithsonian Institution, etc., for the year ending June 30, 1886. Washington, 1889. The Collection of Building and Ornamental Stones in the U. S. National Museum: A Handbook and Catalogue, by George P. Merrill. Part IV, p. 490, foot-note.

§ The specimens were suspended by a fine platinum wire, whose weight when immersed in water to the same extent as when suspending the stone was accurately determined and subtracted from the total weight of the submerged mass.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.

(*Continued from page 554, Volume LXIV.*)

CHAPTER XXX.

HOWE TRUSS BRIDGES.

The designs for Howe Truss bridges of 100 ft. and 120 ft. span are given in the accompanying illustrations; both are through spans. Plate 125 shows the 100-ft. span and Plate 127 the 120-ft. span, the details being given in Plates 126 and 128. Reference is also made to plates recently published for some of the castings required.

The bills of materials for both spans are also given herewith, and with the plates present all that is needed to give information concerning the designs.

These two close the series of designs for Howe truss bridges, which have necessarily been extended over some time, owing to the space required for the plates.

(To be concluded.)

No. 51. Bill of Material for Howe Truss Bridge. Through Span 100 Ft. Plate 125.

Timber.

No. of Pieces.	Description.	Size.	Length.	Feet B. M.	Kind of Wood.
20	Top Chord......	7 in. × 12 in.	20 ft. 0⅛ in.	2,820	Yellow Pine.
4	" "	7 in. × 12 in.	37 ft. 0⅞ in.	1,040	" "
4	" "	7 in. × 12 in.	17 ft. 0¾ in.	480	" "
8	" "	7 in. × 12 in.	7 ft. 0⅛ in.	400	" "
4	Bottom Chord..	7 in. × 14 in.	39 ft. 0 in.	1,274	" "
4	" " ..	7 in. × 14 in.	29 ft. 0 in.	948	" "
4	" " ..	7 in. × 14 in.	38 ft. 0 in.	1,242	" "
8	" " ..	7 in. × 14 in.	40 ft. 0 in.	2,613	" "
4	" " ..	7 in. × 14 in.	18 ft. 0 in.	588	" "
4	" " ..	7 in. × 14 in.	8 ft. 0 in.	264	" "
8	Braces	12 in. × 14 in.	26 ft. 4⅜ in.	2,952	" "
8	"	12 in. × 13 in.	26 ft. 4⅜ in.	2,742	" "
8	"	11 in. × 12 in.	26 ft. 4⅜ in.	2,335	" "
8	"	9 in. × 12 in.	26 ft. 4⅜ in.	1,890	" "
8	"	8 in. × 12 in.	26 ft. 4⅜ in.	1,688	" "
16	Counters.......	8 in. × 10 in.	26 ft. 4⅜ in.	2,810	" "
4	"	8 in. × 10 in.	14 ft. 0 in.	374	" "
8	Laterals........	6 in. × 8 in.	20 ft. 8 in.	662	" "
2	"	6 in. × 8 in.	22 ft. 3⅜ in.	180	" "
8	"	8 in. × 8 in.	19 ft. 3⅜ in.	824	" "
6	"	8 in. × 8 in.	20 ft. 8 in.	660	" "
2	"	6 in. × 8 in.	13 ft. 11¼ in.	112	" "
2	"	8 in. × 8 in.	13 ft. 11¼ in.	150	" "
32	Floor-beams	9 in. × 16 in.	19 ft. 4 in.	7,424	Spruce or Pine.
6	Stringers	6 in. × 12 in.	106 ft. 0 in.	3,816	" " "
91	Ties.............	8 in. × 8 in.	12 ft. 0 in.	....	Oak.
2	Guard rails.....	6 in. × 6 in.	106 ft. 0 in.	636	Spruce or Pine.
16	Bolsters	7 in. × 12 in.	9 ft. 0 in.	876	" " "
16	Bridge-seats....	7 in. × 12 in.	6 ft. 0 in.	672	" " "
4	Sills...........	12 in. × 12 in.	19 ft. 4 in.	928	" " "
4	Planks..........	2 in. × 8 in.	106 ft. 0 in.	566	" " "
8	Blocks........	2 in. × 8 in	2 ft. 8 in.	28	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
12	Rods.......	3 in.	27 ft. 10 in.	16	Bolster b'lts	1¼ in.	2 ft. 4 in.
12	"	2¾ in.	27 ft. 10 in.	16	" "	1¼ in.	3 ft. 4 in.
12	"	2½ in.	27 ft. 10 in.	220	Chord bolts.	¾ in.	2 ft. 9½ in.
12	"	2 in.	27 ft. 10 in.	48	String'rb'lts	⅝ in.	2 ft. 6 in.
6	"	1¾ in.	27 ft. 10 in.	44	T'k strg'b'ts	⅝ in.	2 ft. 10 in.
8	Counters....	1 in.	15 ft. 0 in.	61	Tie-bolts...	⅝ in.	2 ft. 6 in.
6	Laterals....	1¾ in.	20 ft. 0 in.	20	Brace-bolts.	¾ in.	2 ft. 9½ in.
8	" ...	1½ in.	20 ft. 0 in.	64	Spikes.. .	½ in.	9 in.
48	Fl. beam b'ts	1¼ in.	3 ft. 0 in.				

Other Iron Work.

Washers (see Plate 120): 850 of pattern *F*; 176 of *G*; 40 of *H*.

Castings (see Plate 126): 36 of pattern *A*; 4 of *B*; 36 of *C*; 20 of *D*; 8 of *E*.

Castings (see Plate 121): 156 of pattern *L*; 156 of *M*; 64 of *O*; 32 of *P*; 64 of *Q*.

Castings (see Plate 117); 4 of pattern *F*; 96 of *I*.

No. 52. Bill of Material for Howe Truss Bridge. Through Span, 120 Ft. Plate 127.

Timber.

No. of Pieces.	Description.	Size.	Length.	Feet B. M.	Kind of Wood.
24	Top Chord......	7 in. × 12 in.	24 ft. 1 in.	4,044	Yellow Pine.
8	" "	7 in. × 12 in.	20 ft. 0¾ in.	1,125	" "
8	" "	7 in. × 12 in.	8 ft. 0⅛ in.	449	" "
12	Bottom Chord..	7 in. × 14 in.	48 ft. 0 in.	4,704	" "
4	" "	7 in. × 14 in.	45 ft. 0 in.	1,470	" "
4	" "	7 in. × 14 in.	33 ft. 0 in.	1,078	" "
4	" "	7 in. × 14 in.	21 ft. 0 in.	686	" "
4	" "	7 in. × 14 in.	9 ft. 0 in.	294	" "
8	Braces.........	12 in. × 16 in.	26 ft. 11⅝ in.	3,456	" "
8	"	12 in. × 15 in.	26 ft. 11⅝ in.	3,240	" "
8	"	12 in. × 12 in.	26 ft. 11⅝ in.	2,592	" "
8	"	10 in. × 12 in.	26 ft. 11⅝ in.	2,160	" "
8	"	8 in. × 12 in.	26 ft. 11⅝ in.	1,728	" "
16	Counters.... ...	8 in. × 10 in.	26 ft. 11⅝ in.	2,880	" "
4	"	8 in. × 10 in.	14 ft. 6 in.	386	" "
4	Laterals........	6 in. × 8 in.	20 ft. 9 in.	332	" "
2	"	6 in. × 8 in.	22 ft. 4 in.	180	" "
8	"	6 in. × 8 in.	17 ft. 11⅛ in.	576	" "
4	"	10 in. × 10 in.	21 ft. 7 in.	720	" "
10	"	8 in. × 8 in.	22 ft. 4 in.	1,200	" "
2	"	6 in. × 8 in.	13 ft. 11¼ in.	112	" "
2	"	8 in. × 8 in.	13 ft. 11¼ in.	150	" "
32	Floor-beams....	9 in. × 16 in.	19 ft. 4 in.	7,424	Spruce or Pine.
6	Stringers.......	6 in. × 12 in.	126 ft. 0 in.	4,536	" " "
108	Ties............	8 in. × 8 in.	12 ft. 0 in.	....	Oak.
2	Guard-rails.....	6 in. × 6 in.	126 ft. 0 in.	756	Spruce or Pine.
16	Bolsters..... ..	7 in. × 12 in.	9 ft. 0 in.	1,008	" " "
16	Bridge-seats....	7 in. × 12 in.	6 ft. 0 in.	672	" " "
4	Sills...........	12 in. × 12 in.	19 ft. 4 in.	928	" " "
4	Planks..........	2 in. × 8 in.	126 ft. 0 in.	672	" " "
8	Blocks.........	2 in. × 8 in.	2 ft. 8 in.	29	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
12	Rods... ...	2¾ in.	27 ft. 10 in.	64	Fl. beam b'ts	1⅛ in.	3 ft. 0 in.
32	"	2½ in.	27 ft. 10 in.	232	Chord-bolts.	¾ in.	2 ft. 9½ in.
18	"	2 in.	27 ft. 10 in.	48	String'rb'lts	¾ in.	2 ft. 6 in.
8	Counters...	1 in.	15 ft. 0 in.	44	T'kstr'g'b'ts	¾ in.	2 ft. 10 in.
8	Laterals....	1⅝ in.	20 ft. 0 in.	72	Tie-bolts.	⅝ in.	2 ft. 6 in.
8	" ...	1½ in.	20 ft. 0 in.	36	G'rd-r'l-b'lts	⅝ in.	1 ft. 3 in.
16	Bolster b'lts	1¼ in.	2 ft. 4 in.	20	Brace-bolts.	⅝ in.	2 ft. 9½ in.
16	" "	1¼ in.	3 ft. 4 in.	80	Spikes......	½ in.	9 in.

Other Iron Work.

Washers (see Plate 120): 950 of pattern *F*; 208 of *G*; 32 of *H*.

Castings (see Plate 128): 28 of pattern *A*; 8 of *B*; 24 of *C*; 8 of *D*.

Castings (see Plate 126): 4 of pattern *B*; 28 of *C*; 8 of *F*.

Castings (see Plate 121): 156 of pattern *L*; 152 of *M*; 64 of *O*; 32 of *P*; 64 of *Q*.

Castings (see Plate 117): 8 of pattern *F*; 96 of *I*.

THE MANNESMANN TUBES.

At the recent meeting of the Iron & Steel Institute in Pittsburgh, much attention was excited by the display of tubes made by the Mannesmann process, which accompanied the paper read by Dr. Hermann Wedding on the process, which was invented by the brothers Reinhard and Max Mannesmann, of Remscheid, Germany.

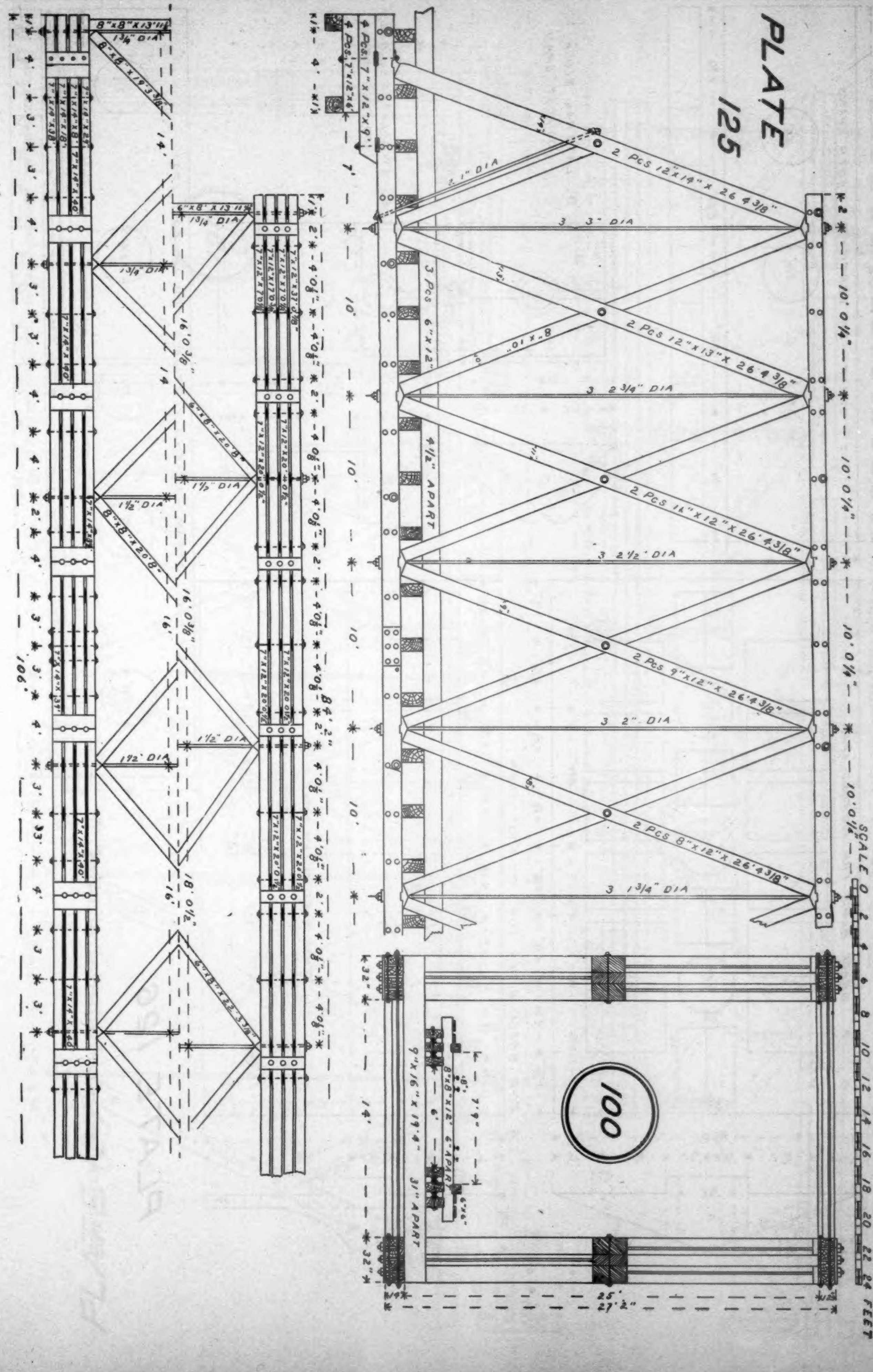
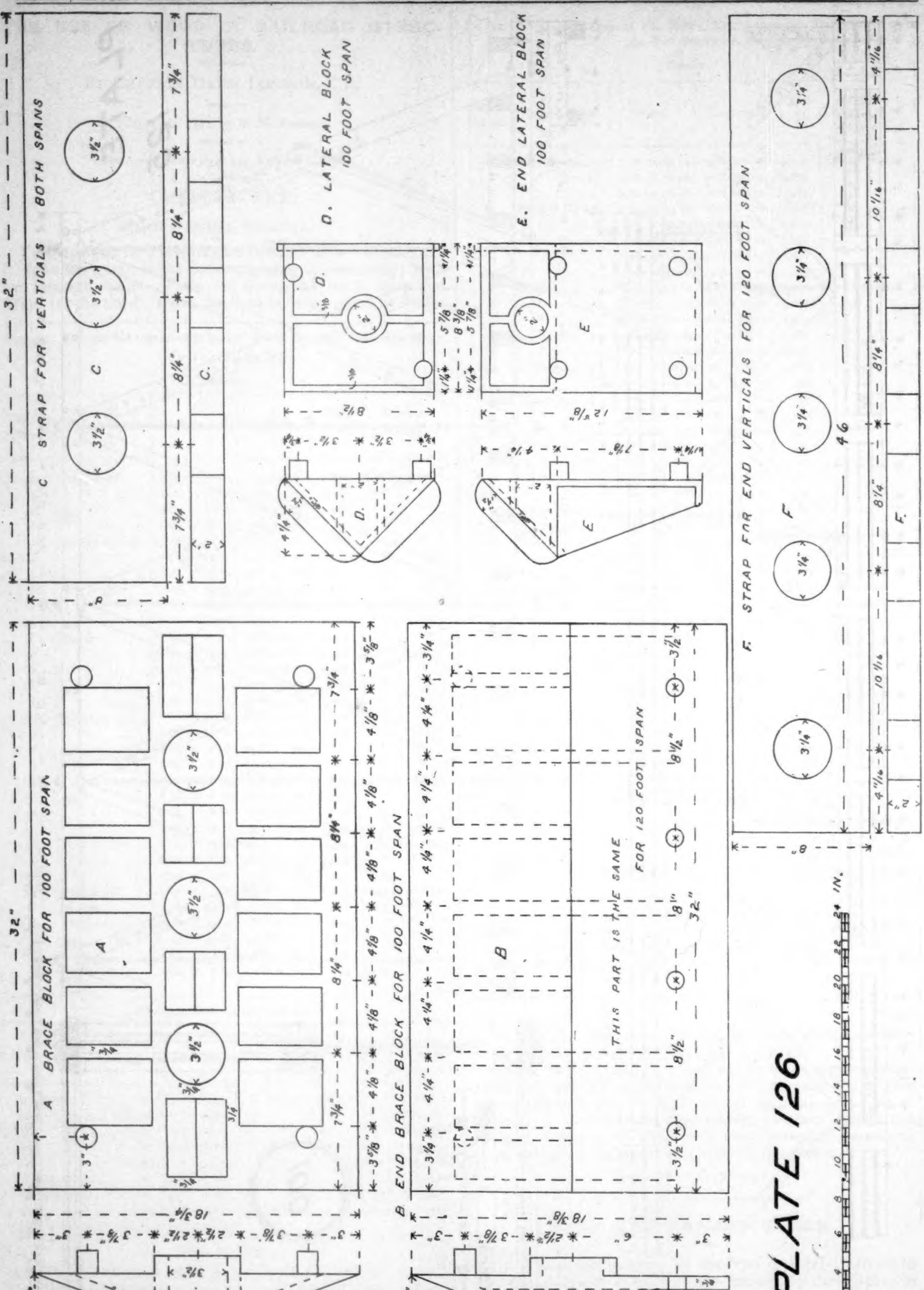


PLATE
125
2 PCS 12"x14"x 26 4 3/8"
2 PCS 12"x13"x 26 4 3/8"
2 PCS 14"x12"x 26 4 3/8"
2 PCS 9"x12"x 26 4 3/8"
2 PCS 8"x12"x 26 4 3/8"
3 3" DIA
3 2 3/4" DIA
3 2 1/2" DIA
3 2" DIA
3 1 3/4" DIA
3 PCS 6"x12"
4 1/2" APART
100
SCALE
FEET


C STRAP FOR VERTICALS BOTH SPANS
D. LATERAL BLOCK 100 FOOT SPAN
E. END LATERAL BLOCK 100 FOOT SPAN
F. STRAP FOR END VERTICALS FOR 120 FOOT SPAN
A BRACE BLOCK FOR 100 FOOT SPAN
B END BRACE BLOCK FOR 100 FOOT SPAN
THIS PART IS THE SAME FOR 120 FOOT SPAN
PLATE 126
SCALE

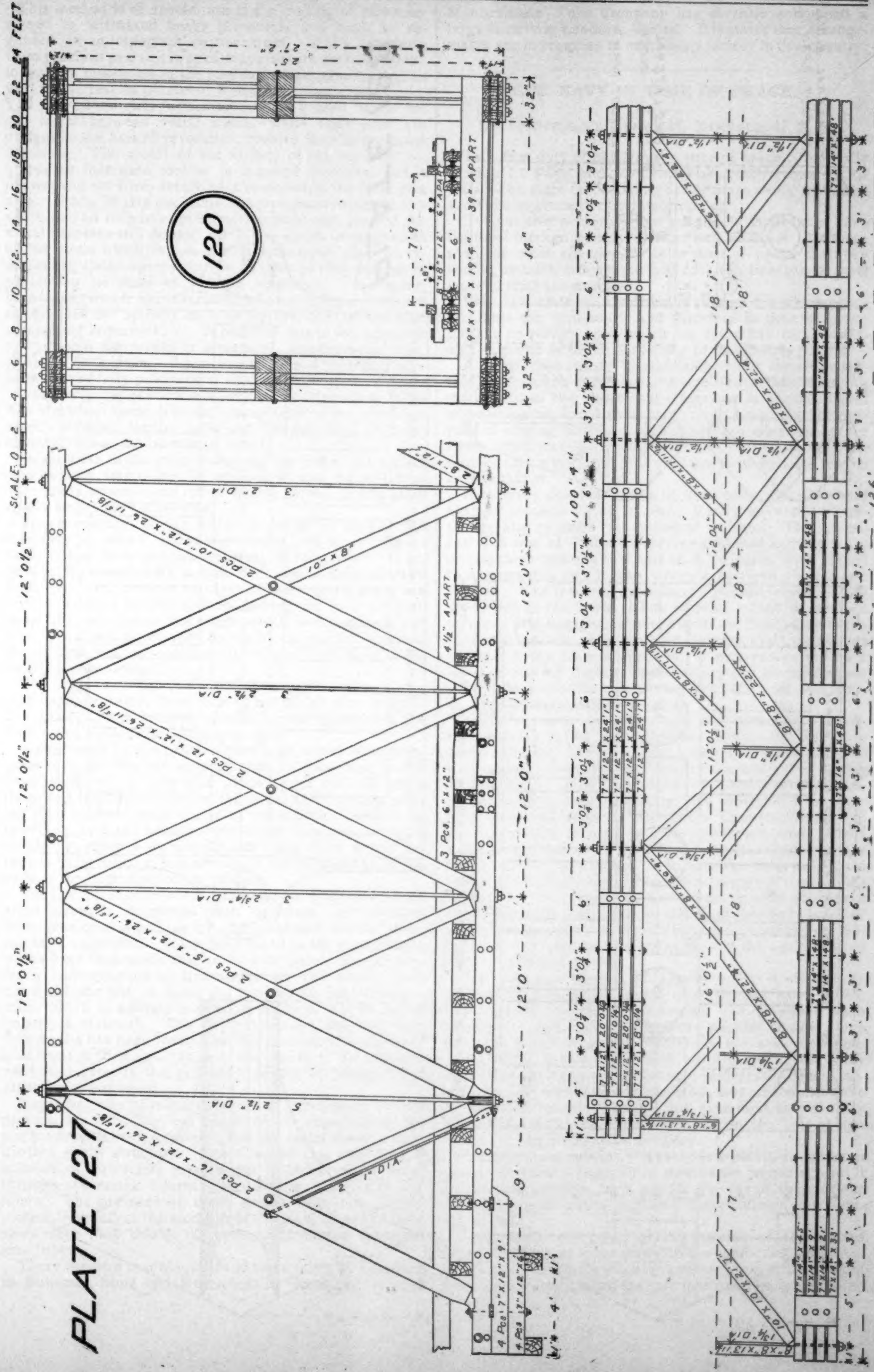
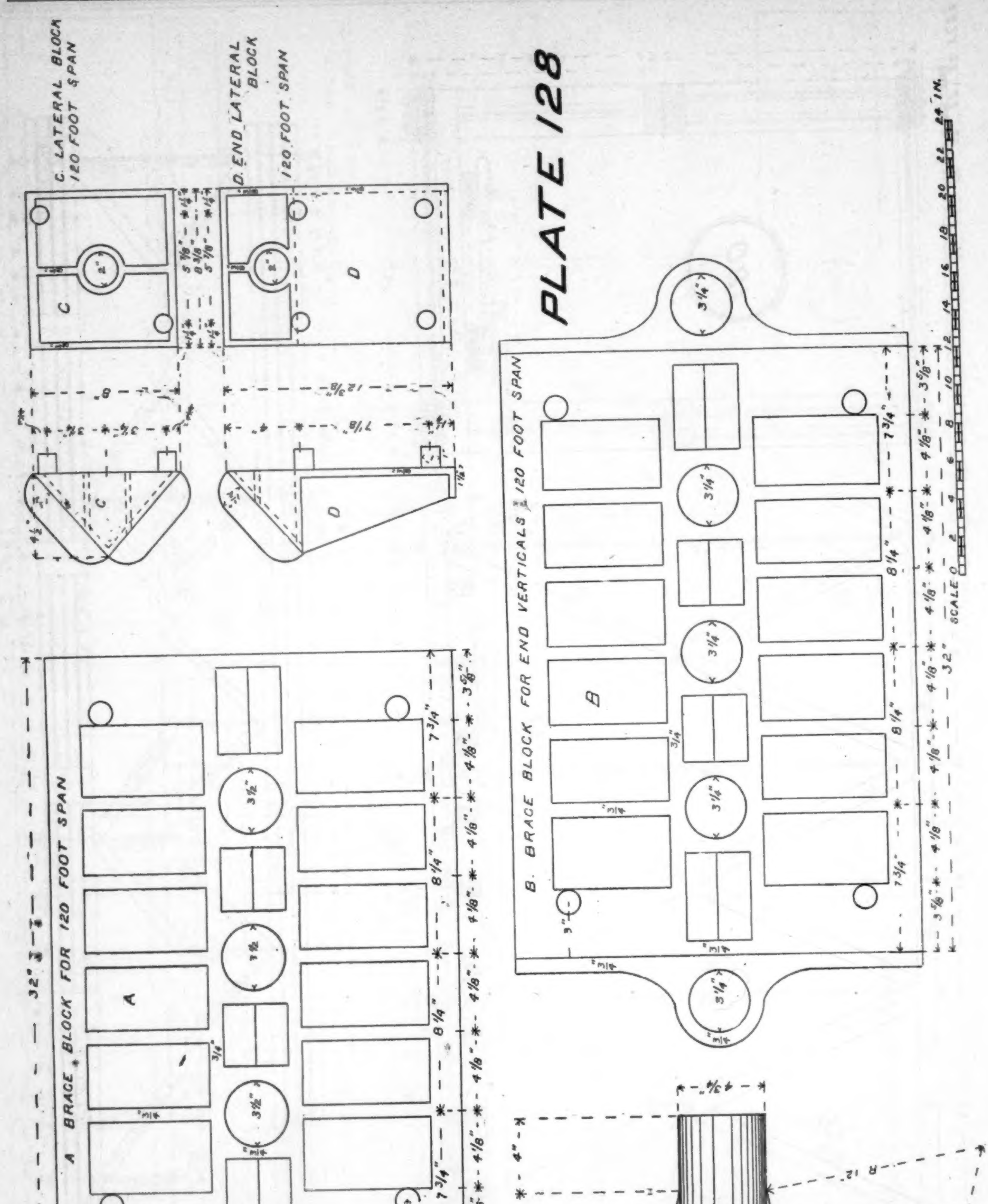


PLATE 127
120
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 FEET
2 PCS 10"x12"x 26' 11 1/8"
2 PCS 12"x12"x 26' 11 1/8"
2 PCS 15"x12"x 26' 11 1/8"
2 PCS 16"x12"x 26' 11 1/8"
3 PCS. 6"x12"
4 1/2" APART
9"x16"x 19' 4"
39" APART
12' 0 1/2"
12' 0"
100' 4"
126'


C. LATERAL BLOCK
120 FOOT SPAN
D. END LATERAL BLOCK
120 FOOT SPAN
PLATE 128
A BRACE BLOCK FOR 120 FOOT SPAN
B. BRACE BLOCK FOR END VERTICALS 120 FOOT SPAN
SCALE
24 IN.

This method is of special use in the making of pipes designed to withstand heavy pressures, and must be regarded as an important improvement. It is a departure from previous practice in such manufacture well calculated to work a revolution in the methods of manufacturing, as well as the results obtained, which are most remarkable. The process consists in feeding a solid, heated bar of ingot metal between rolls, which, while their axes are oblique to the axis of revolution, revolve both in the same direction. The metal of the surface of the bar thus acquires an increased motion in a spiral direction, and is drawn over its core, receiving consequently the form of a pipe. Since, in this operation, the pipe moves spirally forward, and all its parts are spirally pushed and pressed the metal becomes still denser. It is this spiral arrangement of the metal which makes the Mannesmann pipes so remarkable, quite apart from the advantage they possess in presenting no lines of welding whatever. Moreover, blowholes (which are invariably present in ingot iron) are so squeezed out spirally as to make the walls of the pipe completely impermeable. A proof of this is the retention of hydrogen for weeks in a piece of Mannesmann pipe, closed at both ends. Pipes thus made and enlarged have been successfully produced of all diameters up to 18 in.

The designing of the machinery for making these tubes was a work of some difficulty, on account of the very high speeds required for the rolls, and the details of this machinery have so far been kept secret.

In addition to the rolls in making the tubes, a mandrel may be used, improving the product, in that the pipe is at once made smooth and more nearly perfect inside than would be the case otherwise.

The proportion of the inside diameter or bore of the tube may be varied within wide limits. In work thus far done, it has been possible to make a tube, say of 1¼ in. outside diameter, with a bore not larger than a small wire, say $\frac{1}{16}$ in., and in contrast to such tubes, pipes are regularly made by this process having an area of bore equal to 95 per cent. of that of the outside measurement, and even this, it is claimed, may be readily exceeded if occasion should demand, as experiments which have been made clearly demonstrate.

The pipes are made in the ordinary lengths, 18 to 23 ft.; they have, however, been turned out in lengths of 45 ft. and upward, thus insuring a considerable decrease in the number of connecting pieces required.

Tubes made by this proeess have been tested up to pressures of 4,500 lbs. per square inch. It has been found possible to roll a tube of a given length with the walls thicker at the middle than at the ends, and then, by making such tubes of rectangular or other desired section by re-rolling, to make beams or girders of constant strength, this being effected by making the billet from which the tube is to be rolled of less section in the middle than at the ends at the beginning of the process.

The use of Mannesmann tubes for all purposes where great strength, combined with lightness and absolute homogeneity of metal, as for car axles and similar uses, has been suggested. It has been found in the experiments which have been made that an inferior metal, one not perfectly homogeneous in its composition and quality, will not stand the test of being put through the Mannesmann rolls, that it is entirely impossible to form a tube out of imperfect material. This being the case, the very fact that a tube has been formed by this method, it is claimed, is of itself at once a guarantee of the quality of the material used, and gives in the product a degree of safety in use never before attained.

Regarding the physical structure of tubes made by this process, Dr. Wedding has found, in the examinations he has made with the microscope, that the metal shows a very distinct spiral structure. The tubes of cast steel have a number of extremely minute gas bubbles which wind through the metal, following closely the direction of the fibers. The presence of these spaces does not appear materially to affect the strength of the pipe, since the tests show more than double the strength of similar wrought-iron tubes.

There are now manufactories of these tubes at Kotomau in Bohemia, Bous and Remscheid in Germany; and the Mannesmann Tube Company has recently completed a large factory at Landore, Wales. It is stated that arrangements are in progress to establish a factory in this country.

OUR NAVY IN TIME OF PEACE.

By Lieutenant Henry H. Barroll, U. S. N.

The first duty of our Navy in time of peace is naturally to keep its ships and *personnel* constantly prepared for war. The mere fact of being at all times ready will often avert the aggression of a foreign power.

It is not only necessary that we should at all times have the most modern vessels of war, but, in order that these shall be most effective, it is in time of peace that they should be built, when time and care can be taken for their more perfect construction.

War is a state or condition of things for which peace furnishes the drill-hour; and therefore in time of peace there is no service upon which our Navy can be so profitably engaged as in the perfecting of its fighting powers.

A naval force should be constantly ready for active service. Increased speed on the high seas, while bringing the nations of the world closer together as regards travel and commerce, has also brought them nearer for the purpose of waging warfare; and campaigns which in former times would have necessitated months of preparation, now require only a few weeks at most for their decisive results to be attained.

It requires constant study to keep pace with the rapid changes made in the art of war. Each great national conflict greatly modifies the systems of warfare. The American civil war of 1861-65 was fought almost entirely without machine guns, which less than 10 years later played so important a part in the struggle between France and Prussia. The iron-clad monitor of Ericsson revolutionized the navies of the world. The torpedo, which in our civil war was first brought prominently to the front (despite the emphatic protest of all foreign powers that its use was contrary to the Law of Nations), is now recognized as a military arm of highest importance; and all nations are striving to obtain the most destructive—the most annihilating type of this species of weapon.

Torpedoes were used sparingly and with only approximate success during the Rebellion, but were the right arm of the Prussian defense of the harbors of the North and Baltic Seas, preventing the French from using their highly efficient fleet. Later, the attack upon the stationary submarine mine by counter-mining—the explosion of counter-torpedoes—has led to the invention of finer machines; and the automobile torpedo is temporarily supreme, until a more formidable rival shall have been launched upon the world, only to be defeated in its turn, as its predecessors have been, by the study and inventive powers of the nation's defenders. No person can now prophesy what will be the effect, during the next war, of the use of the lately invented smokeless powder; while there is no question but that balloons will play an important part in the settlement of the next national conflict.

War has now become so expensive that it will not be resorted to until other means of settlement have failed. Sober second-thought or arbitration will be called upon to avert it; and, except with those smaller States which have not much at stake, differences are even now generally settled in this way. Still, nowithstanding the many advocates of Courts of Arbitration, Universal Peace Associations, and other Utopian societies, war will continue to be the "last resort of kings," and even now, as in the day of the First Napoleon, victory will be on the side of that nation having the heaviest artillery.

A modern man-of-war has very few points in common with those vessels engaged in mercantile pursuits; and it is not now possible, as it was in the day of the glorious *Essex*, to readily turn captured merchantmen into fighting ships.

Fortunately, the geographical position of the United States removes us from many of the conflicting questions which are continually causing apprehension to the several European States; while the fact that America is composed

principally of republics relieves us from having to keep constantly armed, as does our sister republic, France, against a possible coalition of land-grabbing monarchies.

Yet, while it is unnecessary that our country should be burdened with a navy of such vast proportions as those belonging to European powers of corresponding magnitude, it is equally improvident to allow it to deteriorate to an inefficient condition.

It is hardly likely that any nation would in the present day attempt to invade our coast further than to obtain a foot-hold, and a line of possession extending perhaps a few miles inland from tide-water. Such an invasion as that made by the British in 1814, when our public buildings at Washington were burned and our national records were committed to the flames, will hardly be attempted in the face of our greater strength, and the more improved methods of defense.

The number of vessels to carry provisions and ammunition for an invading army would constitute a fleet of greater proportions than any one nation could assemble. Our remoteness from the European countries removes us from invasion, as the "silver streak" of the English Channel has defended Great Britain from her continental rivals.

But while this isolation furnishes us a safeguard against invasion such as that of the British in 1814, there is not now the need of such invasion to cause an equally severe amount of destruction. With the long-range guns of the present day there is no reason for landing within the limits of a hostile country, when better results can be obtained from a safer position.

The fighting power, as now carried in modern war-ships, does not need to land to make itself felt; while with such glaring examples before us as the burning of the Summer Palace at Peking, the enforcement of opium upon the Chinese people, the bombardment of Valparaiso, Alexandria, etc., and the wholesale murder of Chinese in the River Min, we must admit that civilization has not yet been successful enough to demand of civilized nations immunity for non-combatants from the desolations caused by war.

Although the best authorities on the subject of international law have repeatedly affirmed that undefended cities are to be considered as exempt from bombardment, yet this principle has repeatedly been and will continue to be disregarded. It is therefore imperative that no matter how strong we may be by land—no matter how impossible it may be to invade our Western States—we should have a naval force at least sufficient to prevent a foreign foe from taking up an unchallenged position from which he may best destroy our seaboard cities, or demand from them their full value in ransom.

It is also a mistake to suppose that, owing to our isolated position as regards European powers, we may not be required to take up arms in defense of some foreign question.

Two generations ago President Monroe announced his famous Doctrine, which is now so often alluded to, and one principle of which was to the effect that American territory was no longer susceptible of colonization (colonization being another European term for seizure) by European Powers.

This principle has never been admitted by the European powers themselves; it is likely that it never will be admitted; and the probability is that our being allowed to expatiate upon it so long arises from the jealousies existing among themselves, rather than from any fear on the part of the European governments that we will attempt its enforcement. Even if we once attempted to prevent the interference of those foreign powers in the affairs of American republics, we would possibly have at times to hold the principle in abeyance, as the English now do their insistance on the Right of Search, which was so strenuously held to in former times.

Although the Monroe Doctrine has never been admitted by the European powers, yet so far these have avoided bringing that question to a definite settlement. We have so long advanced it that we could not now honorably neglect to insist upon its observance should the necessity of maintaining its principles arise; and although removed by thousands of miles from European complications, yet the control of the Pacific is a matter of vital importance to the United States; and we will be brought face to face with this question when the Nicaragua Canal nears completion.

The control of this important channel-way must perforce excite the cupidity of some of our friends across the sea. Aden, Perim, Malta, Hong Kong, Tongking, Belize, Cyprus, Suakin, Tahiti, Madagascar, Zanzibar, Massowa, even Egypt, have been colonized (?), bought (?), or protected (?), for far less important reasons!

With regard to a canal across the American Isthmus, the President of the United States said in his annual message of 1880:

> The policy of this country is a canal under American control. The United States cannot consent to the surrender of this control to any European power. The capital invested by corporations or citizens of other countries in such an enterprise must, in a great degree, look for protection to one or more of the great powers of the world. No European power can intervene for such protection without adopting measures on this continent which the United States would deem wholly inadmissible.

Bermuda, that thorn in the Atlantic side of our continent, is of more value to the United States as a strategic point than the entire State of Ohio; and we cannot afford to allow the Sandwich Islands also to pass under European control.

Such reflections serve to make it apparent that, notwithstanding the peaceful character of our nation—notwithstanding our isolated position—notwithstanding our well-known aversion to having foreign possessions, we may, from some such cause, at any moment have quarrels forced upon us; and therefore, in time of peace, as well as in actual warfare, our Navy must be exercised to the highest point of efficiency, and eternal vigilance must still be the price of our liberty.

Having a smaller force than those navies against whom it may be opposed does not diminish, but further accentuates the importance of keeping that force composed of the most modern type of vessels. We must be able to compensate by excellence for our disadvantage in point of numbers. This must be done by constant drill and study. Indeed, the experience of our late civil war demonstrated that there was less need for drills in time of war than during peace. In time of peace, drill is necessarily only a sham affair—the rehearsing of the real tragedy which is afterward to be enacted—and it is, therefore, all the more important that the rehearsals be frequent and well-attended, that the tragedy may be a complete success; but when the company is giving daily exhibitions, private rehearsals are no longer necessary.

It requires from four to five years, with the best plant which our country affords, to build and equip a modern battle-ship, and almost as long to drill into thorough efficiency the crew who are to conduct her into action and fight her guns. With the nucleus which our present Navy furnishes, crews could be drilled into comparative efficiency in less time; but that raw recruits can in so short a time be even partially instructed in their various duties is due to the fact that their drill-masters—graduates of the United States Naval Academy—have been dozens of years acquiring the knowledge which they impart.

There are, then, certain individuals whom the nation cannot afford to discharge in time of peace, because the knowledge and skill which they possess can only be obtained after years of experience and drill.

This necessity of retaining at all times the most skilled men, in a military point of view, extends from the cabin to the forecastle. There are experienced commanders and expert gunners; thorough electricians and skilful coxswains of boats, all well-trained men in their several callings; and although the captain commands the gunner, the coxswain, and the torpedo officer, it does not necessarily follow that he can steer a boat, direct a torpedo, or aim an 8-in. gun with the same skill or precision as can that man who has been found to be specially qualified for that particular business.

In addition to having this technical knowledge, it is also of importance that a person should have, if possible, constant practice in those affairs which he is expected to execute; and during those long periods of peace, which are best for our country in a mercantile point of view, the mili-

tary power naturally deteriorates unless still greater efforts are made to keep it efficient.

The wealth, resources, and abilities of our country would go far toward supplying our want of preparation, but could not obviate the lapse of time necessary to construct the proper means of defense. It is a mistake to rely upon the naval defense of the country by its untrained citizens.

Thirty years of rest, while foreign powers have been supplying themselves with modern ships and improved weapons of war, have placed us now where it behooves each of us to think over and study out the best plans for that defense.

Cincinnatus was suddenly called from the plow to command an army; but Cincinnatus, or even Lord Nelson, for that matter, would have a sorry time of it if suddenly called upon to command the *Philadelphia*, and meet a well-drilled antagonist.

In 1874 Spanish insurgents, then in possession of the city of Carthagena, on the Mediterranean coast of Spain, managed to get to sea with the two Spanish men-of-war, the *Almanza* and the *Vittoria*, but were promptly captured in the Mediterranean, one by an English and the other by a German man-of-war, and were brought back to Escombrera Bay before they had any chance to put their peculiar theories into practice.

One of these insurgent vessels was commanded by a butcher, with an actor as first-lieutenant; and among other amusing incidents connected with their short cruise, shell were found in several of the guns, with no cartridges behind; a small 5-in. shell was found rammed carefully home in an 8-in. gun, while the larger shell had been left in despair, beside the more diminutive 5-in. rifle.

Owing to dissensions, the insurgents decided to surrender to the English and German men-of-war, else there might have been a parallel to the target-practice of the magnificent French fleet against the poorly officered, miserably manned and totally undrilled Chinese wretches in the River Min.

The prosperity of our Navy and that of our merchant marine must go hand in hand, for we can never expect to have an effective naval force so long as the majority of our seamen are drawn from foreign sources. We cannot expect these to have the interest of our country or the honor of our flag very close to heart; and although they can be made to fight through a war, yet it will generally be found that they have enlisted to "fight" only on a peace basis.

We are essentially a land-dwelling people—not an amphibious race such as the Norseman or Dane—and could raise to a corresponding degree of efficiency a powerful army in a much shorter time than that in which we could produce a formidable navy.

In event of sudden war, our Army would at once be re-enforced in both rank and file from a comparatively well-drilled militia. The Navy, for its increase under similar circumstances, would be dependent almost altogether upon the fishing fleet, since our American merchant vessels are manned almost entirely by foreign seamen. Even those additions that might be made from the above sources would be composed of men who, although possibly good sailors, would be utterly ignorant of the military duties of a man-of-wars-man.

The foregoing presents the *raison d'être* of a navy in time of peace—not only to retain, but to increase its efficiency for war; not only to keep in thorough working condition the splendid modern battle-ships, but to also design, build and equip vessels which shall combine the latest and most destructive fighting qualities; not only to keep ourselves, by constant exercise, in thorough practice, but by patience and care to evolve from the raw recruit a well-drilled, well-informed, and well-disciplined soldier *and* sailor.

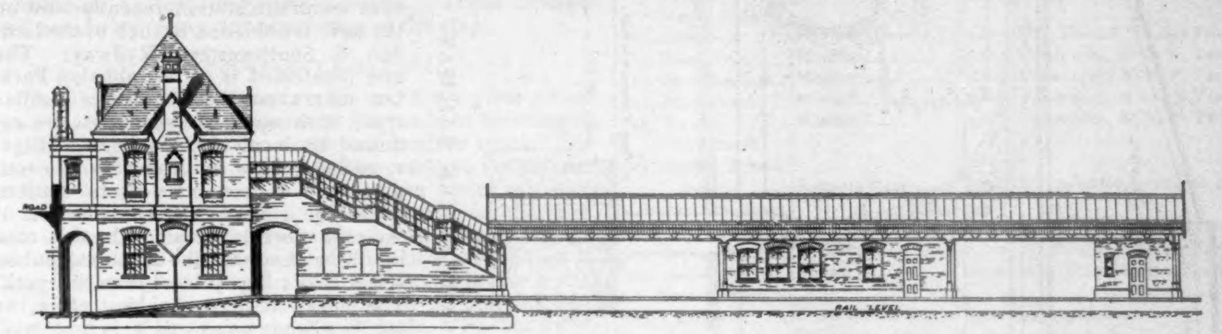


FIG I. ELEVATION AT RAIL LEVEL

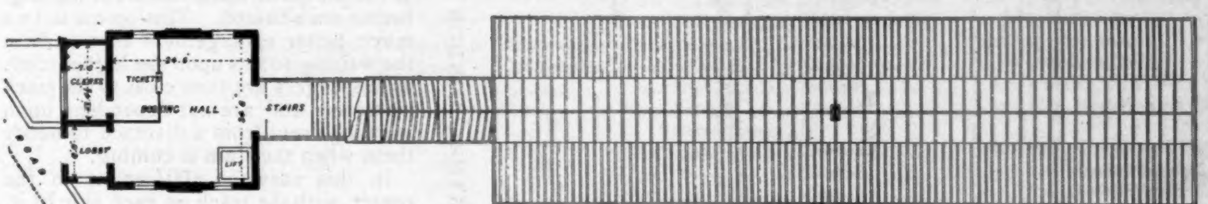


FIG 2. PLAN AT ROAD LEVEL

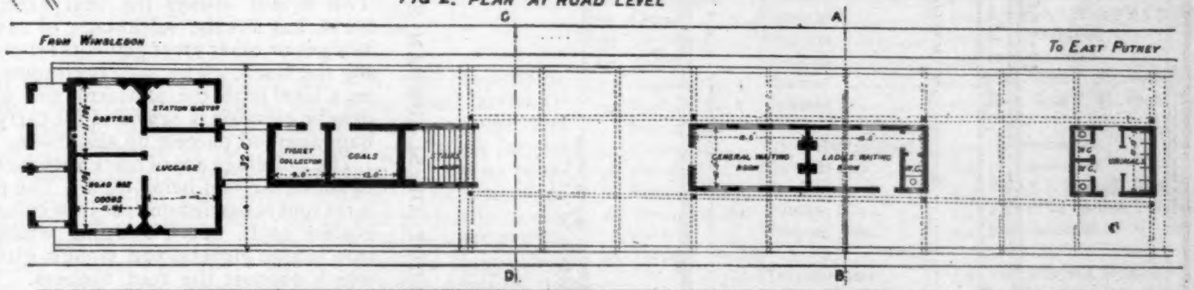
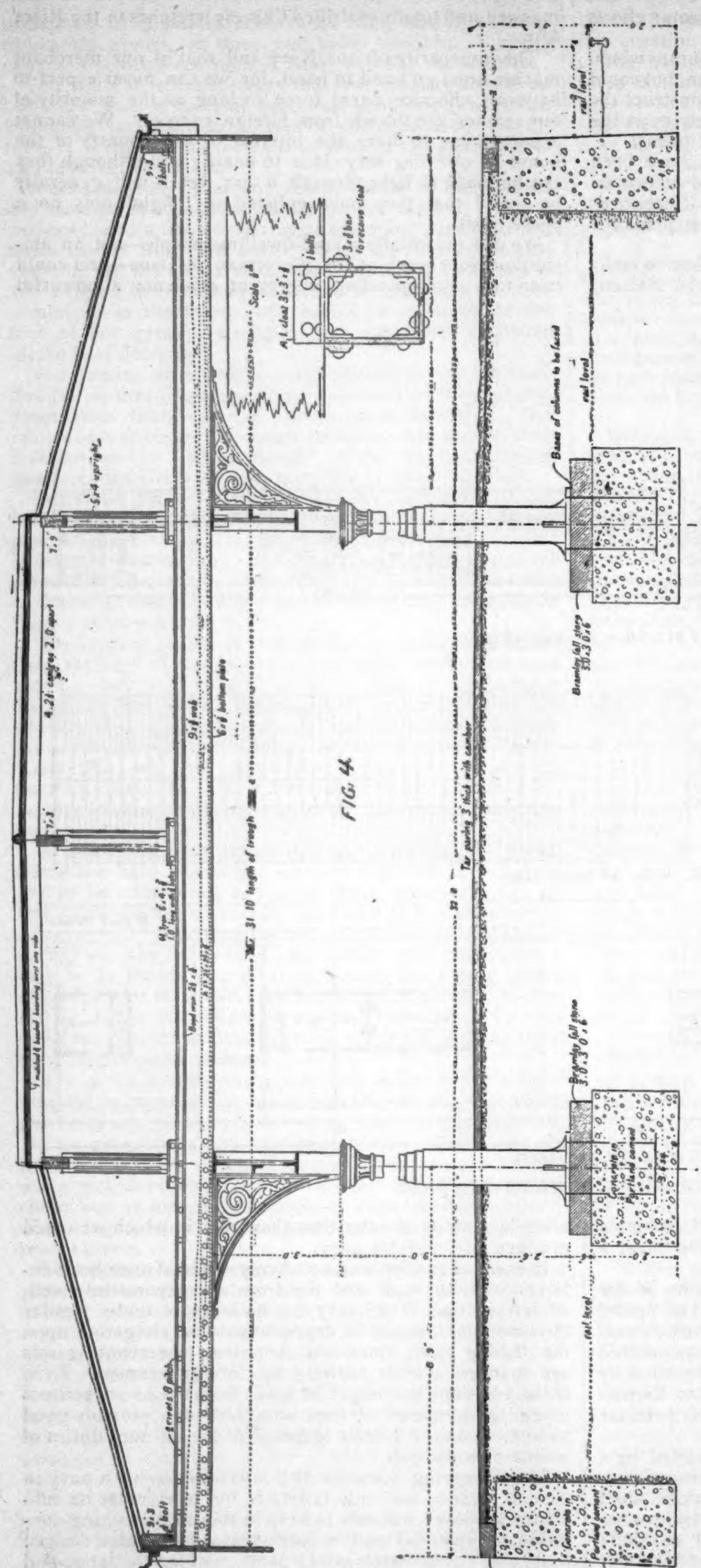


FIG 3. PLAN AT RAIL LEVEL

AN ENGLISH SUBURBAN STATION.



PLATFORM AND ROOF OF SUBURBAN STATION, LONDON & SOUTHWESTERN RAILWAY.

This paramount duty of the Navy being provided for—this end being accomplished — the surplus individuals or vessels belonging to the Navy may be and are employed in various ways to further benefit commerce, etc., while they are not wanted for actual warfare.

(TO BE CONTINUED.)

AN ENGLISH SUBURBAN STATION.

THE accompanying illustrations, from the *Railway Engineer*, show a very neat suburban station recently built on the new Wimbledon Branch of the London & Southwestern Railway. The one illustrated is at Wimbledon Park, but others on the line are of similar type, with such variations as are required by local circumstances. Figs. 1, 2, and 3 show a side elevation, a roof plan, and a floor plan of the station, while fig. 4 shows the construction of the roof more in detail. In this case it will be seen that the adjoining public street is at a higher level than the track. The ticket office, or booking office, as our English cousins call it, is on a level with the road, and after passing it passengers descend a staircase to the level of the platform, upon which the waiting-rooms are situated. This seems to be a much better arrangement than to have the waiting rooms upon the higher level, as passengers are then close to the track platforms and are not dependent upon warnings sent from a distance to notify them when the train is coming.

In this case the platform is in the center, with the track on each side of it. This is not always the best arrangement, but has the advantage of saving bridges or other arrangements for crossing the track. The baggage-rooms are on a level with the platform, and a hydraulic elevator is provided for carrying baggage and parcels up and down.

The buildings are of brick with facings of stone, the roof being tiled. The platform roof is carried on cast-iron columns placed 40 ft. apart, carrying wrought-iron lattice girders and trough girders which support the roof timbers. The roof is of boards covered with zinc. The rain-water is carried from the gutter placed at the eaves by means of the trough girders into the columns, down which it passes and is then carried into a sewer under the platform. The platforms are paved with tar and gravel under the roofing. The signal-box is placed at the end of the platform.

The general construction and arrangement of the roof trusses and the roof is shown in fig. 4. The longitudinal girders which are carried on the iron columns are lattice girders, each 39 ft. 5 in. in length and 24 in. in depth, the top and bottom chords being of T-iron. The roof timbers, which are carried on the trough girders resting on the truss, are 9 × 3 in. in size and the ridge timber 7 × 3 in. The roof rafters, which are placed 2 ft. apart centers, are 4 × 2½ in. in size. The cast-iron columns rest upon concrete foundations provided with a capstone to receive the base of the columns, the top of the capstone being about 2 ft. below the platform level.

THE UNITED STATES NAVY.

THE new gun boat *Bennington*, which is a sister ship to the *Concord*, is to have considerable alterations made in her. The chief of these is the addition of a flush spar deck extending the whole length of the ship, and the substitution of two masts for three. The effect will be to give her more stability and make her a better sea boat. The changes are the result of experience with the *Yorktown* as a cruiser. A change in the battery will be made also, and instead of six 6-in. guns, the *Bennington* will have eight 5-in. guns, four mounted amidships, two forward and two aft. With these changes it is believed that she will be a more efficient cruiser, while her armament will be quite as formidable as that originally planned. These changes will somewhat delay the completion of the ship.

THE SECRETARY'S REPORT.

The report of the Secretary of the Navy gives an extended account of the progress so far made in building up a navy composed of vessels of the best modern types. Under existing contracts nearly all the vessels so far planned will be completed by 1893. All of those under construction have been from time to time described in our columns, and in the accompanying table are given all the new ships, the construction of which has so far been authorized by Congress, the present condition of each being briefly noted.

NEW SHIPS FOR THE UNITED STATES NAVY.

Vessel.	Description.	Displacement, Tons.	Condition.
Armored Ships.			
First Rate:			
1. *New York*	Cruiser	8,100	Bldg. Cramp & Sons, Phila.
2. *Maine*	Cruiser	6,648	Launched, N. Y. Navy Yard.
3. *Texas*	Battle-ship	6,314	Bldg. Norfolk Navy Yard.
4. *Puritan*	Monitor	6,060	Building, N. Y. Navy Yard.
5. *Indiana*	Battle-ship	9,900	Bldg. Cramp & Sons, Phila.
6. *Massachusetts*	Battle-ship	9,900	Bldg. Cramp & Sons, Phila.
7. *Oregon*	Battle-ship	9,900	Bldg. Union I. W., San Fran.
Second Rate:			
8. *Monterey*	Monitor	4,003	Bldg. Union I. W., San Fran.
9. *Amphitrite*	Monitor	3,815	Under com., N'f'k N. Yard.
10. *Miantonomoh*	Monitor	3,815	Under com., N. Y. N. Yard.
11. *Monadnock*	Monitor	3,815	Under com., M. Is'd N. Yard.
12. *Terror*	Monitor	3,815	Under com., N. Y. N. Yard.
Third Rate:			
13. Harbor Defense Ram	Armored Ram	2,000	Bids ca'ed for, op'ed Dec. 20.
Unarmored Ships.			
First Rate:			
14. Cruiser No. 6	Cruiser	5,500	Bldg. Union I. W., San Fran.
15. Cruiser No. 12	Cruiser	7,400	Bldg. Cramp & Sons, Phila.
Second Rate:			
16. *Chicago*	Protected Cruiser	4,500	In commission.
17. *Baltimore*	Protected Cruiser	4,400	In commission.
18. *Philadelphia*	Protected Cruiser	4,300	In commission.
19. *Newark*	Protected Cruiser	4,083	Ready for trial.
20. *San Francisco*	Protected Cruiser	4,083	Nearly ready for sea.
21. *Charleston*	Protected Cruiser	3,730	In commission.
22. *Boston*	Cruiser	3,189	In commission.
23. *Atlanta*	Cruiser	3,189	In commission.
24. *Cincinnati*	Cruiser	3,000	Building, N. Y. Navy Yard.
25. *Raleigh*	Cruiser	3 000	Bldg. Norfolk Navy Yard.
Third Rate:			
26. Cruiser No. 9	Cruiser	2,000	Bldg. Columbian I. W., Bal.
27. Cruiser No. 10.	Cruiser	2,000	Bldg. Columbian I. W., Bal.
28. Cruiser No. 11	Cruiser	2,000	Building, H. Loring, Boston.
29. *Bennington*	Gunboat	1,700	N'ly r'y, R'ch y'd, Ch'ter, Pa.
30. *Concord*	Gunboat	1,700	R'y for tr'l, R'ch y'd, Ch., Pa.
31. *Yorktown*	Gunboat	1,700	In commission.
32. *Dolphin*	Gunboat	1,485	In commission.
33. Gunboat No. 5	Gunboat	1,050	Bldg. Bath I. W., Bath, Me.
34. Gunboat No. 6	Gunboat	1,050	Bldg. Bath I. W., Bath, Me.
Fourth Rate:			
35. *Vesuvius*	Dynamite Gunboat.	970	In commission.
36. *Petrel*	Gunboat	870	In commission.
37. Practice ship	Gunboat	835	Bldg. S. L. M're&S., Eliz., N. J
38. Torpedo cruiser.	Gunboat	750	Bids to be opened, Feb. 11.
39. *Cushing*	Torpedo Boat	100	In commission.
40. Torpedo boat No. 2	Torpedo Boat	112	Bids received, Dec. 20.
41. Dynamite No 2.	Dynamite Gunboat.	970	Construction suspended.
Unclassed.			
42. Armored Cruising Monitor	Armored Cruiser	3,030	Construction suspended.

NOTE.—The construction of Dynamite Gunboat No. 2 depends upon the success attained with the *Vesuvius*, and has not yet been ordered. The armored cruising monitor—sometimes referred to as the Thomas monitor—will probably not be built at all.

Hardly less important than the work of building new ships is that of supplying them with guns. The following table gives the number of sets of forgings so far ordered, the number of guns completed, and the number of guns now under construction at the Washington Gun Foundry:

Caliber.	Forgings Ordered.	Completed Guns.	Guns under Construction.
4-in.	35	4	12
5-in.	4	2	..
6-in.	128	77	25
8-in.	35	15	2
10-in.	25	4	3
12-in.	8	..	..
13-in.	12	..	..

Of the above guns, the 4-in. and 5-in. may properly be classed as rapid-firing guns, employing fixed ammunition, that is to say, having the cartridge case, charge, and projectile combined in one. The 5-in. gun is the largest that present investigation and experience indicate as properly adapted to the quick-firing feature. The combined weight of the cartridge case, charge and projectile in this gun is estimated not to exceed 100 lbs., which can be handled without difficulty. Beyond this it is inexpedient to go, as the great weight of the projectile prevents the rapidity of fire, which is this gun's essential feature. A specimen of the 4-in. gun has been completed and tried and has given highly satisfactory results, two types, differing in their breech mechanism, having been manufactured.

The adoption of rapid-firing guns of large caliber has made it necessary to develop a plant for the manufacture of suitable cartridge cases, and an agreement has accordingly been made with the Winchester Repeating Arms Company of New Haven, Conn., to supply 15,000 cases, with the option to the department to order 10,000 more at a reduced price. The company has nearly completed the machinery necessary for making these cases, and their delivery will soon begin.

Passing to the heavy guns, the first is the 6-in., the length of which has been increased from 30 to 35 calibers. The performance of the new gun is satisfactory, and specimens will soon be made with a still longer bore, a gun 40 calibers in length having been designed for this purpose.

Of the 8-in. guns, six of the new designs, 35 calibers in length, have been manufactured, tested with good results, and issued, and a new 8-in. gun, 40 calibers in length, has been designed which it is proposed to mount on Cruiser No. 12. The great advantage of this gun, as of all long guns, is the flat trajectory of the projectile, due to its high velocity, which makes it possible to use the gun successfully at ordinary battle range without accurate measurement of distance.

Of the 10-in. guns, four that make up the armament of the *Miantonomoh* are completed, and three of the four for the *Maine* are in an advanced stage of manufacture.

No 12-in. guns have yet been made, but forgings for one gun have been received from the Bethlehem Iron Company, and the gun factory is ready to proceed with the manufacture of these guns as fast as forgings are delivered.

The design for the first 13-in. gun, 35 calibers in length, has been completed, and the tools for its manufacture are in course of construction. Twelve sets of forgings of this size have been ordered from the Bethlehem Iron Company for the batteries of the three new battle ships.

All contracts with private firms for the manufacture of heavy guns have been completed in the course of the past

year, and the guns have been proved and issued to the service. No further contracts of this character will be made with private firms, the capacity of the gun foundry at Washington being sufficient to handle forgings as fast as they will be received.

The ordnance work of the past year has included the completion and installation of the armaments of the *Baltimore*, the *Philadelphia*, the *San Francisco*, and the *Miantonomoh*, while those of the *Newark* and *Concord* are ready.

The 8-in. guns of the *Charleston* are also ready and will replace four of her 6-in. guns on her return. The manufacture of a new armament for the gunnery ship *Lancaster* has been begun. It is believed that with the increased rapidity of delivery of forgings from the Bethlehem and Midvale Companies and the development of the Washington Gun Foundry, batteries can hereafter be furnished to new ships as fast as the latter are completed. The Midvale Company is now engaged in putting up a plant for forgings of large calibers, and by the early part of next year will probably be able to do machining up to 10-in. guns, and to cast and forge up to 13-in. There will, therefore, be two firms in the United States ready to supply any gun forgings that are likely to be needed.

The improvements at the gun foundry during the past year include the erection of the 110-ton overhead traveling crane, the completion of the shrinkage pit, gun carriage shop, and office building, the construction of a siding from the Baltimore & Potomac Railroad, which has greatly facilitated deliveries and shipments, and the purchase of a shifting engine and of several special machine tools.

It is satisfactory to note that with these improvements, both the cost of manufacture and the time required have been largely reduced—in the case of the 6-in. gun from $2,649 and 115 days to $1,298 and 60 days.

Under the act of June 30, 1890, the Navy Department, on September 19 last entered into contract with the Ericsson Coast Defense Company for one submarine gun and six steel projectiles, the gun and projectiles to be fixed and secured in position on board the steam vessel known as the *Destroyer*.

It is proposed to make a thorough test of this system of submarine artillery, which possesses undeniable advantages, if applied to special types of vessels, such as the ram designed for work at close quarters. The experiments will be conducted at the Torpedo Station at Newport.

Cast-iron common shell and shrapnel have been manufactured at Washington and supplied to the new ships as fast as needed. The manufacture of cast-steel common shell has been discontinued for the present, the results obtained not having proved satisfactory. Efforts have been made to develop in this country a process of making common shell of forged steel, as this shell possesses marked advantages, and it is hoped that before long specimens may be obtained for test and that the manufacture may be domesticated in the United States.

The specimens of armor-piercing projectiles hitherto received from private firms in this country, tempered by various processes, have not proved satisfactory, and the only present prospect of securing what we need is by the adoption of some one of the processes in use abroad. A contract has been made for a quantity of projectiles to be manufactured in America by one of these processes, and the Department is still endeavoring to bring about some arrangement by which it may obtain other armor-piercing shells of the best quality of American manufacture.

The great number of inventions, possessing more or less merit, in the way of light rapid-firing guns, has multiplied the number of types in use in all the navies of the world. The manifest disadvantage of this extreme diversity of types, each with its special ammunition, on board a single ship has led the Department to look with favor upon a plan to limit the smaller rapid-firing pieces to the 6-pounder and 1-pounder calibers, and to abandon as fast as is practicable the 3-pounders and the 47-millimeter and 37-millimeter revolving cannon.

The Driggs Ordnance Company has begun work on the ten 6-pounder and the ten 3-pounder guns and ammunition ordered last year.

The Hotchkiss Ordnance Company has filled its original contract with the Department for 94 Hotchkiss guns and ammunition, with the exception of steel shell for the 6-pounder and 3-pounder, in the manufacture of which, of the proper quality, considerable difficulty has been experienced. Deliveries have also been made under later orders.

Owing to delays in the completion of the great armor making plant at Bethlehem, which seem to have been unavoidable, the Department has let contracts for about 6,000 tons of armor, not covered by the contracts with the Bethlehem Company, to Carnegie, Phipps & Company, of Pittsburgh. Deliveries by this company will begin in June next, and by the Bethlehem Company in October.

Further tests are to be made of nickel-steel plates, which are to be very thorough and careful. Until these are completed no extensive purchases of nickel or nickel-steel will be made.

The contract with the Hotchkiss Ordnance Company for torpedoes has not yet been filled. Contracts have been made for a number of Whitehead automobile torpedoes. Some successful tests have been made of the Patrick torpedo.

The Secretary recommends an increase in the number of Rear-Admirals, now insufficient; he also recommends an increase in the number of Commanders and Lieutenant-Commanders, and a decrease in that of Lieutenants, in order to equalize and regulate promotion, and to prevent the exaction of too long terms of service in subordinate grades. A somewhat similar readjustment in the Engineer Corps and an increase in the number of engineers is required.

In conclusion the Secretary again calls attention to the unprotected condition of our sea-coasts, and urges upon Congress the necessity of a fleet of efficient fighting ships to aid in the protection of our harbors and seaport cities. This part of the report is interesting, but space forbids more than the briefest summary here.

The necessity for an efficient Naval Reserve, and the policy of encouraging the formation and training of a naval militia is also dwelt upon at some length.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

(*Continued from page 557, Volume LXIV.*)

II.—THE TRANS-BAIKAL RAILROAD.

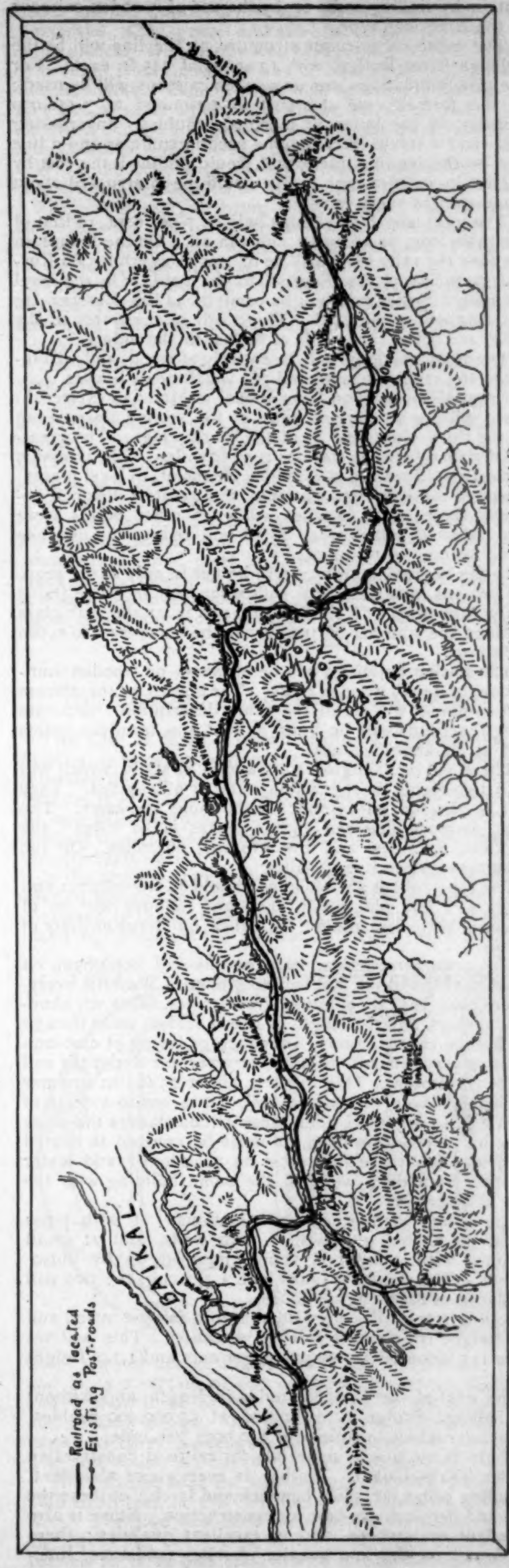
The Trans-Baikal Railroad being intended to connect steam navigation on Lake Baikal with the navigable waters of the Amour River, its starting-point would necessarily be one of the harbors on the eastern shore of Lake Baikal. There are three such harbors, Boïarskaia, Misovskaia and Kluïevskaia; and the explorations made of them having indicated that of Misovskaia as the most suitable, it was adopted as the starting-point of the line.

The eastern terminus of the railroad will be Sretensk, on the Shilka, the principal tributary of the Amour; that river is not suitable for navigation above Sretensk, although it carries a considerable volume of water.

The whole length of the main line from Misovskaia to Sretensk is 663 miles, and branches to the ports or landings on Lake Baikal, the Selenga and Shilka rivers will require 6 miles more, making a total of 669 miles.

The location was not easy, the line having to traverse a heavy mountain country and to cross the Jablonovoï Range. Notwithstanding this, almost the whole line—with an exception of 14 miles only—was located under the conditions of the level sections; that is, with maximum grades of 0.8 per cent. and a minimum radius of curvature of 2,100 ft. Under these circumstances some particulars of the location will be of interest.

From the starting-point at Misovskaia the line follows for some distance the shore of Lake Baikal, then enters the valley of the Selenga River, running between the river and the foot-hills of the neighboring mountain range. Here the direction is northeast, but soon turns southward, still in the Selenga Valley, but crossing many rocky hills and



THE TRANS-BAIKAL SECTION OF THE GREAT SIBERIAN RAILROAD.

passing through the Hamar-Daban Range. At Verkhne-Oudinsk the line crosses the Selenga and turns northeast again, following up the Ouda River nearly to its source.

The further location is governed by the best crossing of the Jablonovoï Range. The descent of those mountains on the eastern side into the valley of the Chita River—which belongs to the Amour system—was the most difficult portion of the line, the height of the pass being 1,120 ft., and the distance in which the descent must be made being short. Thirteen passes, on an extent of 66 miles, were explored by barometric leveling, and the most suitable one found was that of the Shoïdak River, a small stream belonging to the Amour watershed.

Having this in view, the line follows up the Ouda, generally on the side hill, to the mouth of the Pogromma, above which point the valley of the Ouda becomes a rocky gorge, too narrow for the road. It then follows up the valleys of the Pogromma and its tributary, the Kourmuk, reaching a plateau covered with small lakes. Traversing this plateau in a general easterly direction it enters the valley of the Domna, a small river belonging to the Lena system, which is followed until the divide between the headwaters of the Ouda and the Domna is reached and crossed. In ascending this divide it was necessary to put in some zigzags, using radii of 1,750 ft., in order to keep within the limits of grade.

The line then follows the southern or Ouda side of the divide, and on the 330th mile reaches the highest point on the railroad, 3,670 ft. above the sea. This point is the summit of the divide between the Ouda, in the Baikal watershed, and the Tala, a tributary of the Konda, and here the road enters the watershed of the Lena, whose waters flow northward to the Arctic Sea.

Descending the valleys of the Tala and the Konda and ascending that of the Mongoi, the line then rises to the summit of the chosen pass in the great Jablonovoï Range, and finally enters the watershed of the Amour, and descends the eastern slope of the range, following the valley of the Shoidak. The highest point here is on the 400th mile, and is 3,427 ft. above the sea. This point marks the divide between the Lena and the Amour watersheds; that is, between the waters flowing northward to the Arctic and eastward to the Pacific Ocean.

From this divide the line descends the valley of the Shoidak with a continuous grade of 1.2 per cent. to the Chita; from the mouth of the Shoidak it still runs southward, following the Chita River to the town of Chita, the capital of the Trans-Baikal Territory. Thence, turning southeast, it descends the valley of the Ingoda, following the left bank of that stream to the point where it unites with the Onon to form the Shilka River, which, as before stated, is one of the chief tributaries of the Amour.

Entering the flat valley of the Shilka, at first a number of rock cuts and embankments with retaining walls will be needed. Following the left bank of the river, the line crosses the Nercha River not far from the Nerchinsk Iron Works, and reaches its terminus at Matakan, the station there being opposite the town of Sretensk, which is on the right bank of the river, and is the starting-point for steamboat navigation.

Along the whole line only the valley of the Ingoda and that of the Shilka are inhabited; the rest of the country is almost deserted, being peopled only by the half-savage Bouriates, who lead a nomadic, pastoral life.

As above stated, the length of the main line is 663 miles; of this 649 miles come under the conditions of level sections, only 14 miles being mountain sections, with grades of 1.2 per cent., and curves of a minimum radius of 1,400 ft.

In working the line the section containing the mountain passes, from Konda to Chita, 56 miles, will be considered a mountain section, and the trains will be run between those stations with two engines.

For the level sections the maximum grade is 0.8 per cent. and the minimum radius of curvature 2,100 ft., the grade being reduced to 0.75 per cent. where curves of 1,750 ft. radius are used on the zigzags or spirals. For the mountain sections the minimum radius of curvature is 1,400 ft., and the maximum grade 1.2 per cent. This grade, however, is found only in one direction, so that

trains going eastward will encounter no grade over 0.8 per cent.

Under these circumstances on the Chita-Konda, or mountain section, a passenger train of 30 cars will require two engines going westward, but only one going eastward. Freight trains will be handled in the same way; it is expected that the standard freight train will consist of 28 loaded cars in summer, but of 20 only in winter.

The grade is designed for single track only; it will have a standard width of 16.8 ft., the slopes being 1½ or less.

The estimated average quantity of earthwork is about 33,200 cub. yds. per mile; that is, 24,030 cub. yds. of embankment, 3,200 of earth cutting, 1,870 of stone cutting, and 4,100 cub. yds. of rock cutting.

The most difficult earthwork is met with on the shore of Lake Baikal, in crossing the Jablonovoï Range, and on the banks of the Ingoda and the Shilka. The soil is of different descriptions, but generally hard; the stone cuttings will require the use of powder or dynamite. The rocks in the Jablonovoï Mountains are full of water. The subsoil in this country is always frozen, and the cuttings, which at different points reach to a depth of 25 ft. in ordinary soil, 76 ft. in stone and 116 ft. in rock, will be very difficult.

Along the banks of the Ingoda and the Shilka at several points retaining walls will be required. These will be in dry masonry, and the total estimated quantity is 716,000 cub. yds.

The bridges, as designed, will be of different descriptions, as follows:

1. Arch culverts of masonry: 2 each of 7 ft. span.
2. Wooden bridges with masonry abutments: 194 of 7 ft. span and 14 of 14 ft. span.
3. Small wooden bridges: 713 in number, with a total length of 4,991 ft.
4. Small iron bridges: 7 of 20 ft. span; 2 of 35 ft. span, and 1 of 56 ft. span.
5. Large wooden bridges and trestles: 30 in all, as shown in the following table:

Number.	Length.	Remarks.
1 bridge	35 ft.	Clear span
1 "	42 "	"
2 bridges	49 "	"
6 "	56 "	"
7 "	70 "	"
3 "	105 "	"
1 bridge	126 "	Over Mantourika River.
2 bridges	140 "	Nikitikha and Baruntala Rivers.
2 "	210 "	Mongoi and Kia rivers.
1 bridge	280 "	Talacha River.
1 "	455 "	Ouroulga River.
1 "	455 "	Khodoun River approach.
3 bridges	700 "	Brian, Konda and Chita rivers.
Total, 31 bridges	5,432 ft.	Total length.

6. Large iron bridges with masonry abutments: 9 in all, as shown in the following table:

Bridge.	No. of Spans.	Length of Spans.	Total Length.
....	1	70 ft.	70 ft.
....	1	70 "	70 "
....	1	70 "	70 "
Kouenga River	2	245 "	490 "
Krouchina River	1	280 "	280 "
Ouda River	2	245 "	490 "
Khodoun River	1	245 "	245 "
Nercha River	4	210 "	840 "
Selenga River	13	245 "	3,185 "
Total, 9 bridges	26	....	5,740 ft.

The total number of bridges and culverts is thus 973, or 1.45 per mile; their total length, 18,204 ft., or a little over 27 ft. to the mile.

The total quantity of iron required for these bridges will be about 3,000 tons. Masonry foundations will be put in by sinking wells or by the use of wooden caissons of the American type.

The most conspicuous structure on the line will be the Selenga River Bridge, with 13 spans of 245 ft. each. For the pier foundations iron or wooden caissons will be used; in the former case the cost is estimated at 3,150,000 roubles, in the latter at 2,900,000 roubles. In crossing this river a steam ferry may be used in summer and a line laid on the ice in winter; this would diminish the cost by 2,750,000 roubles, but traffic would be interrupted about three months every year.

The total length of sidings will be 7 per cent. of that of the main line, or about 47 miles in all. On the mountain sections the rails used will be of a type weighing 60 Russian pounds (54½ lbs. English) to the yard. On the level sections a lighter rail will be used, of 54 lbs. Russian (49 lbs. English) to the yard. There will be 2,416 ties to the mile, and 2,300 cub. yards of ballast to the mile.

The road buildings will be entirely of wood, and will include 163 section-houses and 263 watchmen's houses.

From Misovskaia on Lake Baikal to Matakan (Sretensk) there will be 24 stations, four of the second class, seven of the third class, and 13 of the fourth class. The greatest distance between stations is 35.67 miles. The intervals between stations are divided by means of 19 level places, intended for fifth-class stations; the greatest distance between these is 18.67 miles, while 42 other points were also selected, which when filled will reduce the distance to an average of 10 miles.

In the beginning sidings will be put in only at the regular stations, and these will suffice for running three trains daily each way. If sidings are put in at the fifth-class stations the number of trains can be increased to seven each way.

The station buildings will be of wood, on wooden foundations and with wooden roofs. The houses for the officers and employés will be of the same description. Separate freight stations will be built only at the terminal points and at Verkhne-Oudinsk.

There will be 11 engine-houses with 77 stalls, which will hold two-thirds of the whole number of engines. They will be of wood, with wooden foundations and roofs. The least distance between engine-houses is 40 miles; the greatest, 83 miles, and the average, 66 miles. On the mountain section it is 53 miles.

The repair shops are designed to hold 29 locomotives and 40 cars. The blacksmith shop and foundry will be of masonry with iron roofs; the other buildings entirely of wood.

The arrangements for water supply will be difficult on account of the frozen state of the ground. Water is everywhere, and can be obtained from rivers, lakes or abundant springs, and the height of rise is seldom more than 70 ft.; but the construction of aqueducts or laying of cast-iron pipes is very difficult, because at a certain depth the soil is always frozen. This depth is about 25 ft.; in summer the upper layer, or surface soil, thaws out to a depth of from 2 ft. to 10 ft. Under these circumstances the pipes must be placed very deep, or must be covered in heated galleries; otherwise they must be abandoned, and water pumped from deep wells in the same building with the tank or reservoir.

The plans include 43 water-stations: 11 with pipes placed in heated galleries, 11 with wells, and 21 small stations with temporary supply pumped up by pulsometers. The standard tanks hold 1,372 cub. ft.; two will be placed at each engine-house.

Rolling stock will be provided at first for one mixed and two freight trains daily in each direction. This will require 115 locomotives, 57 passenger cars and 1,140 freight cars.

The cost of the line, 669 miles in length, and without the Selenga Bridge, is estimated at 55,000,000 roubles, or 82,200 roubles (a little over $40,000) per mile.

There is no lack of materials for railroad construction in the Trans-Baikal. Timber is everywhere abundant, including cedar, fir, pine, hemlock and larch; of these the pine and hemlock are best for construction. Stone is also abundant everywhere, and of excellent qualities; there are found on the line granite, diorite, sandstone, lime-

stone, marble, quartz, schist and pudding-stone, or conglomerate. Clay, gravel and sand for ballast are found in many places. Iron for the iron bridges and the rails must be brought from Russia by way of Nicolaevsk, the Amour and the Shilka. Cement must also be brought from Russia; but as some 13,000 tons will be required, and as the materials can be obtained on the line, the construction of cement works would be economy.

While the population of the Trans-Baikal is not large, laborers can be obtained for the building of the road; but it will be necessary to bring from Russia good foremen, and probably all the skilled workmen, carpenters and masons, since very few of the former and none of the latter are to be found there at present.

Masonry can be laid in the open air only for three months of the year—June, July and August. Much of this work will have to be done during the winter, in heated sheds.

The climate of the Trans-Baikal is continental. The variations in daily temperature are sometimes as much as 30° Cent. (54° Fahr.). The air is dry and the rain-fall small, not over 300 mm. (11.8 in.) yearly. Snow falls very seldom, and scarcely covers the soil. From Verkhne-Oudinsk eastward sleighing on the roads is rare, and sledges are used only on the rivers, following the ice. There are only three months of the year in Verkhne-Oudinsk when the daily minimum temperature is not above the freezing point. For three years past the maximum temperature noted is 37.2° Cent. (98° Fahr.); the minimum,—46.6° Cent. (—51.9° Fahr.). In a word, the climate is that of an elevated plateau, open to the winds from the north, and remote from the tempering influences of the sea.

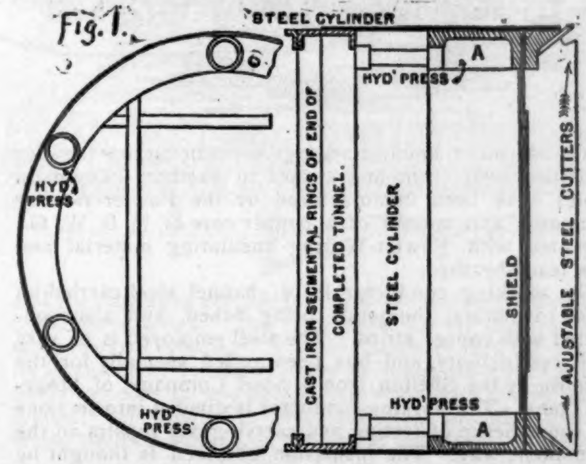
(TO BE CONTINUED.)

THE LONDON ELECTRICAL RAILROAD.

THE City & South London Railroad, just opened in London, is remarkable from the fact that it is the first considerable line in England worked by electricity, and also because it is placed at a much greater depth below the surface than the other underground lines in that city. It is about three miles in length, extending from the heart of the city southward.

In the accompanying illustrations fig. 1 shows the shield used in boring the tunnel—which is somewhat similar to that used in the Hudson River Tunnel—on the Greathead plan; fig. 2 shows the interior of a car; fig. 3 is an in-

Fig. 1.



terior view of one of the stations; fig. 4 is an elevation, and fig. 5 a section of one of the locomotives: figs. 6, 7 and 8 show three of the stations, which are of peculiar and striking design. All the stations have hydraulic elevators to carry passengers to and from the platforms. The description is from the London *Electrician*.

The railroad is of the subway type, passing from King William-Street, in the City, under the Thames, to Stockwell. The line has been constructed on a method designed by Mr. Greathead, in the form of two circular iron tunnels 10 ft. in diameter, driven throughout the London clay, and about 60 ft. below the surface. The method of working resembles the sinking of a caisson. A steel shield was forced forward while material was excavated. When a sufficient advance had been made, a ring of cast-iron plates was built up, and a lime grout was forced into the space left by the sides of the shield between the lining plates and the soil. A speed of 16 ft. per day was attained, and since the tunnels were commenced several other im-

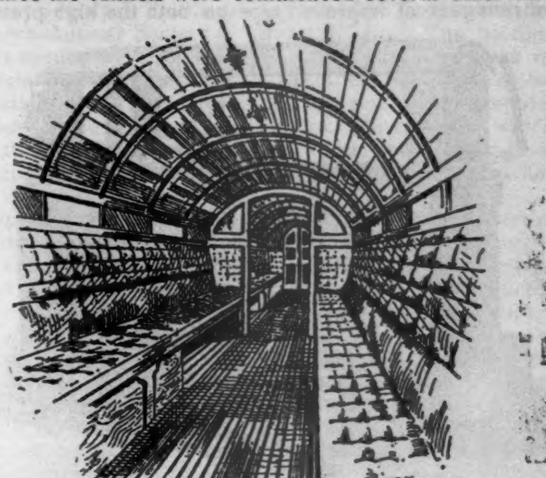
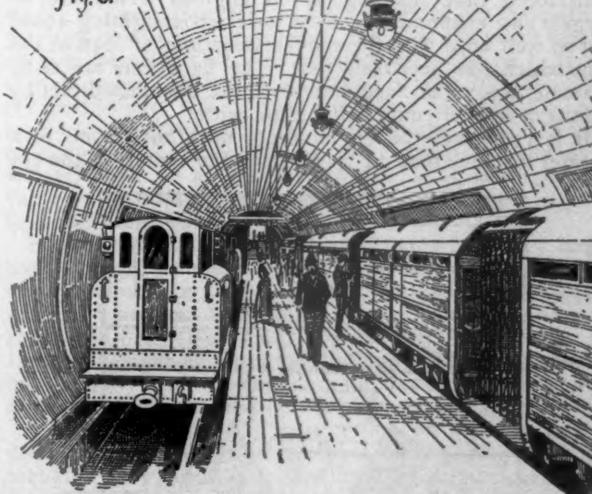


Fig. 2.

portant works have been constructed, or are in progress, on the same plan. Near the Stockwell terminus an old watercourse, consisting of gravel, with a considerable quantity of water, was encountered. The air-lock principle, for which this system is excellently adapted, was employed, and after some delay in providing the necessary machinery, which it was hoped might have been unnecessary, the tunnels were satisfactorily completed. It was originally intended to work the railroad by cable, but tenders were invited for running it by electricity, and eventually plans were submitted to the Company by Messrs. Mather & Platt, and the Company accepted this firm's

Fig. 3.



scheme, which is based upon the experience obtained by Dr. Edward Hopkinson in the construction of the Bessbrook-Newry Electrical Railroad. The contractors employed Messrs. John Fowler & Company, of Leeds, to supply the boilers and engines, and Messrs. Beyer, Peacock & Company to construct the framework of the electrical locomotives. All the electrical plant has been carried out under the special superintendence of Dr. Edward Hopkinson. Dr. John Hopkinson has acted throughout as Consulting Engineer, and Mr. G. A. Grindle as Resident Engineer.

The whole of the generating plant is situated at Stockwell, the suburban terminus of the line. It consists of three large Edison-Hopkinson dynamos, each worked independently by a vertical compound Fowler engine. The engines work at a steam pressure of 140 lbs. per square inch, and have been built of exceptionally massive proportions. They run at 100 revolutions, giving a piston speed of 450 ft. per minute. They are fitted with automatic expansion gear of improved type on both the high-pressure

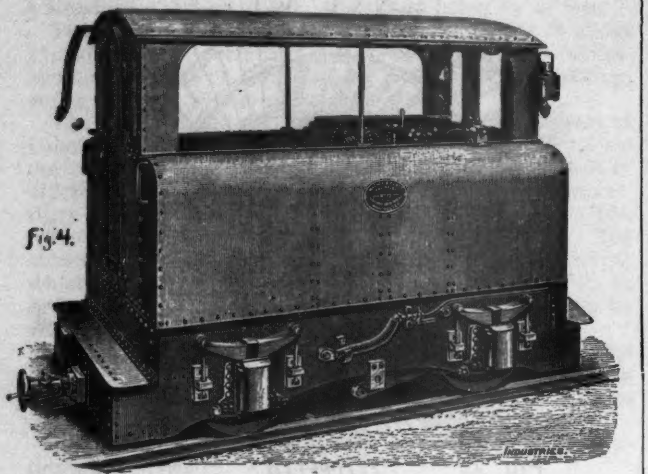


Fig. 4.

and the low-pressure cylinders, and are controlled by a powerful governor having a capacity of 750 foot-pounds, which is driven direct from the crank-shaft by cotton ropes. The automatic gear is so arranged as to cut off the steam, if necessary, in both cylinders from dead cut-off to three-quarters stroke. The engines have high-pressure cylinders 17 in. in diameter and low-pressure cylinders 27 in., the stroke being 27 in.; they indicate up to 375 H. P. each. The pistons are fitted with Mather & Platt's rings and springs, and the valves are specially arranged with multiple parts which reduces their movement considerably and still allows a very prompt action; as the ports are as close as possible to the end of each cylinder, the loss of pressure by wire drawing is very small. Large and slow-speed engines were selected on account of the very irregular nature of the work, it being considered that the high-speed engines which are so largely and economically used for electric lighting could not so well cope with the sudden variations of load as the type which has been selected. The fly wheels are 14 ft. diameter and 28 in. face, and drive the dynamos direct by means of leather chain belts 26 in. wide.

It is a pity that the engine-room does not permit of a greater distance than 24 ft. between the centers of the en-

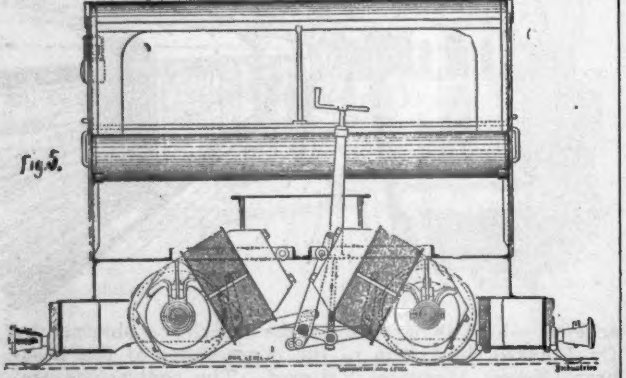


Fig. 5.

gines and that of the dynamos, since jockey pulleys are rendered necessary. These are all very well as an expedient, but are not often to be met with in an important station of this kind. The engines are supplied with steam from six Lancashire boilers 7 ft. diameter by 28 ft. long, which are fitted with Vicar's mechanical stokers.

Livet's boiler setting is used, which provides flues of a varying area, and which, in conjunction with the mechanical stoker, is said to effect a saving of fuel, and certainly succeeded on the occasion of our visits to the depot in preventing smoke. Two large feed-water heaters are also supplied with brass tubes of ample surface for receiving the whole of the exhaust steam from the engine without back pressure.

The 202-kilowatt dynamos are fitted with all the latest improvements; the weight of the armature alone, which is drum wound with spiral ends, being about two tons, the weight of the entire machine being something over 17 tons. Each machine is capable of generating 450 volts and 450 amperes. There are three brushes on each rocking arm, each separately adjustable with a forward thrust and hold-off catch. The magnet limbs are exceedingly massive, each limb with its pole piece being over four tons, and the yoke of the machine weighs about three tons. The machines can be run either as shunt or compound as required. The total weight of copper wire on the magnet of each machine is nearly 3,300 lbs. The present machines have an electrical efficiency of slightly over 96 per cent., and the commercial efficiency of the engine and dynamo—*i.e.*, ratio of the electric power available outside the dynamo to the indicated H. P. of the engine, is over 75 per cent. Two dynamos are capable of working the trains on the line at any time.

The current is conveyed from the dynamos to a general distributing and testing switch-board, fixed in a recess of the engine-house. From this board, which resembles in some respects the Westinghouse switch-board, which is very well known, the main circuits are taken to various parts of the line, and the current passing through each cir-


Fig. 6.

cuit is measured, suitable arrangements being provided for switching over from one circuit to another. The main cables have been manufactured by the Fowler-Waring Company, and consist of a copper core of $\frac{61}{14}$ B. W. G., insulated with Fowler-Waring insulating material and then lead-sheathed.

The working conductor is of channel steel carried on glass insulators, the joints being fished, and also connected with copper strips. The steel employed is of very high conductivity, and has been rolled specially for the purpose by the Shelton Iron & Steel Company, of Stoke-on-Trent. The working conductor is divided into sections for convenience of testing and carrying out repairs on the permanent way. The insulation obtained is thought by the contractors to be extraordinarily high. When the full pressure of 500 volts is on the complete system of working and feeding conductors, the leakage current does not exceed one ampere, so that the total loss by leakage is less than 1 H. P.; this is a small fraction of 1 per cent. of the total power required for working the line to its full capacity. The current is collected from the working conductor by sliding shoes of iron or steel arranged in a very similar way to that employed on the Bessbrook line.

Fourteen electric locomotives have been supplied by Messrs. Mather & Platt for working the line, each capable

of developing 100 effective H. P., and of running at about 25 miles per hour. The locomotives are constructed so that the shafts of the armatures are the axles of the locomotives. The driving wheels run at about 240 revolutions per minute when the locomotive is travelling at 20 miles per hour. The locomotives have a fixed wheel-base, and

Fig. 7

a motor is fitted to each axle, the axles not being coupled, but working independently. The current is conveyed from the collecting shoes through an ammeter to a regulating switch, then to a reversing switch, thence to the magnets and back through the frame-work of the locomotive to the rails. The locomotives are fitted with Westinghouse automatic air brakes, and also a screw hand-brake, and they

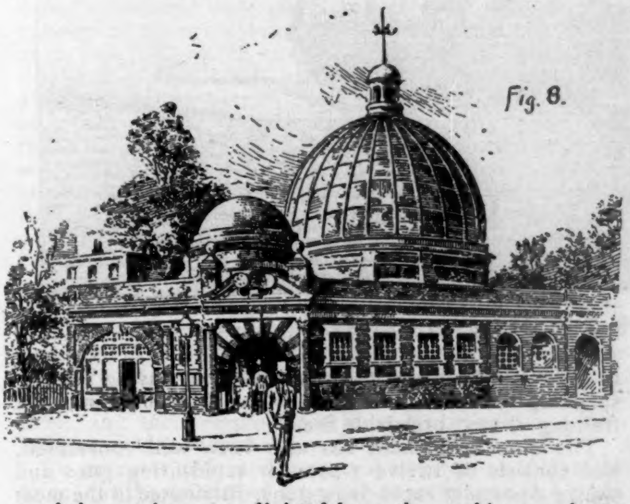


Fig. 8.

and the carriages are lighted from the working conductor by lamps in series. The compressed air for the brakes is stored in two cylinders, 12 in. in diameter, and the capacity is sufficient for three times as many stoppages as are likely to occur in any double journey. The trains, when loaded, will weight 30 tons, and it is intended that 10 trains shall be worked on the line at one time.

FLYING MACHINES.

Mr. Hiram S. Maxim, in a letter published recently in the New York *Times*, writes as follows :

I would say that I have been studying this question about 18 years, principally in the direction of finding some powerful and light motor, but during the last two years I have been employing myself largely evenings to working out the mathematical part of the problem. I have obtained all the data in German, French and English. I have also examined the experimental apparatus in France, but am sorry to say that all the data and information so far obtained are of very little value. A single letter written by Professor Richard A. Proctor, and which was published in a Boston newspaper, furnished more real information than tons of the work which has been published in Europe. Some 25 years ago a society was formed in England styled the Aeronautical Society of Great Britain. The patrons of this society were the Duke of Argyll and the Duke of Sutherland, and the society also numbers among its members many other noblemen and engineers of high repute. I believe there are 19 different volumes in existence which give an account of all their procedures and experiments, but during all these years very little practical work has been done.

I would say that among the large numbers of societies to which I belong in England the Aeronautical Society is one, and need I say that I am the most active member? At the present moment experiments are being conducted by me at Baldwin's Park, Bexley, Kent, England, with a view of finding out exactly what the supporting power of a plane is when driven through the air at a slight angle from the horizontal. For this purpose I constructed a very elaborate apparatus, provided with a great number of instruments, and arranged in such a manner that I can ascertain accurately the efficiency of a screw working in air, the amount of power required to drive a screw, the amount of push developed by a screw, the amount of slip, and also the power required for propelling planes through the air placed at different angles, as well as to ascertain the friction and all other phenomena connected with the subject. I have been experimenting with motors, and have succeeded in making them so that they will develop one horse-power for every 6 lbs. My experiments show that as much as 133 lbs. may be sustained in the air by the expenditure of one horse-power ; of course, it is premature now to express any opinion ; still, if I am not very much mistaken, and if some new phenomenon which I do not understand does not prevent it, I think I stand a fair chance of solving the problem, and I think I can assert that within a very few years some one—if not myself, somebody else—will have made a machine which can be guided through the air, will travel with considerable velocity, and will be sufficiently under control to be used for military purposes. I have found in my experiments that it is necessary to have a speed of at least 30 miles per hour—that 50 miles is still more favorable, and that 100 miles would seem to be attainable. Everything seems to be in favor of high speed. Whether I succeed or not, the results of my experiments will be published, and as I am the only man who has ever tried the experiments in a thorough manner with delicate and accurate apparatus, the data which I shall be able to furnish will be of much greater value to experimenters hereafter than all that has ever been published before.

In order to conduct these experiments I rented a large park—in fact, an old manor—and erected a wooden shed of large dimensions. I provided myself with every requisite and employed two eminent American mechanics to assist me—Mr. Henry A. House and Mr. Henry A. House, Jr., both of Bridgeport, Conn. These gentlemen have already been working with me more than a year, and both seem very confident of our ultimate success.

I appreciate fully the presumption on my own part of attempting to solve this problem, considering that all mankind have failed up to this time. Nevertheless, it is a fact that we do see in nature machines which do fly, some birds weighing nearly 50 lbs. each ; even a common goose can fly without any considerable effort. It is true that no one has ever taken hold of the question in the same way and with the same appliances that I have. Most of the experiments have been confined to small machines weighing only a few ounces and having for a motor a twisted rubber string or spiral spring. If an experimenter has had the necessary intelligence and mathematical knowledge, he has not had the necessary room or money to conduct his experiments, and the results so far have been nil, but I feel satisfied that if such men as Mr. Westinghouse,

Mr. Charles Brush, and Mr. Edison should seriously and earnestly attempt to solve the question they would succeed in making some sort of machine that would fly, but they would have to do as I have done—obtain a place where there would be plenty of room, provide themselves with the very best of mechanics, and spend about $50,000. I would say that the two motors which I have made, and which weigh 600 lbs., cost their weight in silver, while an engine of very much less power, made by a French experimenter, cost more than three times its weight in silver.

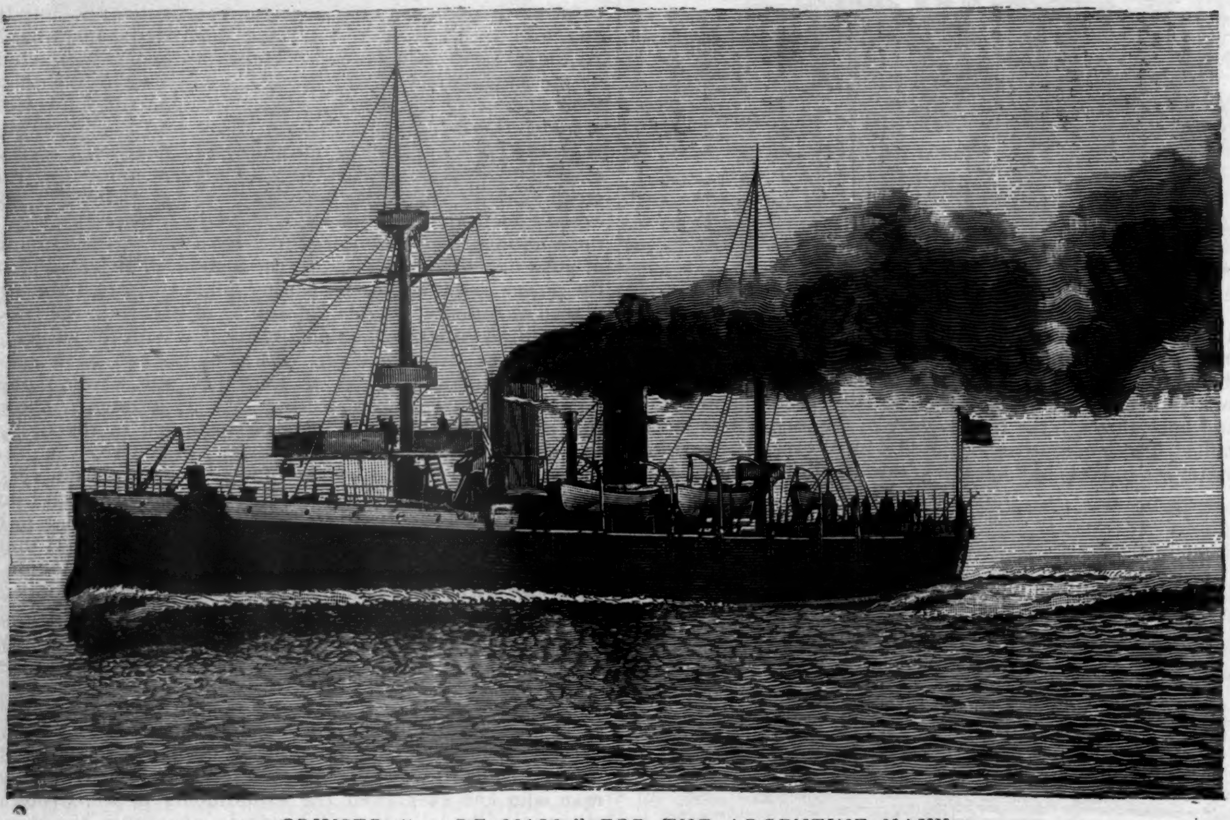
THE FASTEST CRUISER.

It is hardly safe to speak now of the "fastest cruiser," when each new one seems to excel its immediate predecessor. The new ship, *25 de Maio*, built for the Argentine Republic by Armstrong & Company at their works at Elswick, England, seems for the present to hold the record for speed. This vessel is shown in the accompanying illustration—for which and the description we are indebted to the London *Engineer*—which was drawn from an instantaneous photograph taken when the ship was running at the rate of 21¼ knots an hour.

The steam trials of the *25 de Maio*, which have just been completed, mark a distinct step in the speed attained by fast cruisers. This vessel, which is of the twin-screw protected cruiser type, has been constructed by Sir W. G. Armstrong, Mitchell & Company for the Argentine Government, which may well be congratulated on the acquisition of such a splendid specimen of naval engineering. She is somewhat larger than the *Piemonte*, which was built by the Elswick firm for the Italian Government, and which, as our readers will remember, on her completion about 18 months ago, herself broke the speed record. The dimensions of the *25 de Maio* are as follows: Length between perpendiculars, 325 ft.; breadth, 43 ft.; mean draft, 16 ft.; displacement, 3,200 tons.

The machinery and vital parts of the ship are protected by a strong steel deck extending throughout the whole length of the ship, such as is usually adopted in this class of vessel, but of unusual strength, being 4½ in. thick on the sloping sides and 1½ in. thick on the horizontal portions. Above this deck is constructed a deep raft body divided into numerous watertight compartments, which may, if desired, be filled with cork or other water-excluding material, thus insuring buoyancy to the ship even if riddled in action.

The vessel is armed largely with the formidable rapid-firing guns recently introduced by the Elswick firm, arranged to have the largest effective arc of training. On the forecastle, firing right ahead and to 45° abaft the beam on each side, is a 21-cm. (8.27-in.) breech-loading gun. A similar gun is mounted on the poop firing right astern, and with an arc of training equal to that of the forecastle gun. On the upper deck in sponsons along the sides are arranged eight 12-cm. (4.72-in.) rapid-firing guns, the foremost pair being capable of firing right ahead to 45° abaft the beam, the two aftermost having a corresponding stern fire, and the four midship guns an arc of training of 120° broadside fire.



CRUISER "25 DE MAIO," FOR THE ARGENTINE NAVY.

The minor armament has also been well considered, and consists of twelve 3-pounder rapid-firing guns and twelve 1-pounder rapid-firing guns, distributed in the most effective manner, six of the 1-pounders being mounted in military tops on the two masts.

The modern locomotive torpedo has not been overlooked, for the vessel is provided with three 18-in. torpedo guns, two of them training on the broadside and one fixed in the bow. The machinery was constructed by Messrs. Humphrys, Tennant & Company, of London, and consists of two sets of four-cylinder triple-expansion engines and four double-ended boilers, each set of engines and each pair of boilers being placed in separate compartments.

The steam trials, which have just taken place on the Admiralty measured mile off the mouth of the Tyne, were attended by a Commission of Argentine Officers, including Captain Spurr, Captain Garcia, Captain Ramirez—commander of the vessel—and Colonel Warren on behalf of the Argentine Government; Mr. P. Watts, designer of the vessel, on behalf of the Elswick firm; and Mr. Robert Humphrys representing the constructors of the machinery.

At the official trials a run of six hours' duration was made with natural draft, in accordance with Admiralty conditions; and, while this trial proceeded, a number of runs with and against the tide were made on the Admiralty measured mile, the results of which demonstrated that a speed of 21.237 knots per hour had been maintained during the whole six hours' run. During this trial the mean power developed was 8,700 indicated H. P. At the forced draft trial, which was made at the close of the day, when the fires were in bad condition and the stokers tired, the mean speed attained was 22.43 knots per hour, and the mean power 13,800 indicated-horses. Throughout the day the engines worked in a most satisfactory manner, without a hitch of any kind, and the Argentine Commission were highly delighted with the performance of the ship.

The vessel carries 300 tons as her normal supply of coals, but bunker capacity is provided for 600 tons. With the full supply of coal she could steam about 2,000 knots at full speed, natural draft; while, at the most economical speed, she could steam from 9,000 to 10,000 knots.

THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 562, Volume LXIV.*)

IV.—GENERAL CONSIDERATIONS.

Unquestionably the submarine mine has, in the eyes of the military layman, if one may use the term, an exaggerated and fictitious value. While the view that it will practically replace all other means of coast defense is no longer held by the most sanguine, still even among military men it is believed to be given too prominent a place in the problem of sea-coast defense. Such a misunderstanding as to their true value would be of little importance, as a matter of popular belief, except as it might have an influence upon national legislation and be felt in the question of appropriations. But an erroneous opinion among professional military men—artillerists and engineers—into whose hands are confided the defense of port and harbor, means an entirely different thing. If in placing too much reliance upon the mine, at the expense of the battery and gun, we are leaning upon a broken reed, such misplaced confidence can only lead to the most deplorable results if we are ever called upon to face a powerful maritime foe.

There is by no means a unanimity of view among these two classes of military men as to the extent and conditions under which mines should be used, or the ultimate reliance to be placed upon them when employed. In any case they can only become one of the factors in the problem of defense, and their employment must be brought into harmonious relations to the general plan.

To properly plan and carry out a system of submarine mines for the defense of a harbor or water-way is a problem that demands the intelligent co-operation of the artillerist and the military engineer. The conditions to be satisfied pertain not only to matters that belong properly to the domain of the engineer—the character of the channel to be guarded, its depth, width, and nature of its bottom, the swiftness of its current and the rise and fall of its tides—but also to the configuration of the land, the location and strength of the shore batteries, their range, the volume, and maximum field of their fire.

The first question to be decided is the extent to which mining shall be resorted to in closing a water-way—that is, the number, size, and distribution of the individual mines. If the channel be narrow and the artillery defense of the first order, less attention would be given to mine defense than if the contrary conditions prevailed, having in mind always the importance of the position to be protected, either as a point of vantage for military operations, or for the levying of contributions or the destruction of property. It may be taken for granted that, with few exceptions, the importance of a seaport, either from a military or commercial point of view, will vary directly with the draft of water and consequently with the tonnage of the shipping that can be carried to its wharves.

If the channel be narrow and deep the solution becomes comparatively simple. The mines, however few in number, should be distributed upon more than one line to guard against the opening of a passage by the destruction of a single charge. In any case, the general rule will hold that whether the mines be arranged singly or in groups, the individual mines shall be so placed that it will be impossible for a vessel to pass without coming within the destructive area of one or more of them; guarding always against the possibility of a premature explosion of any one of a system by the shock of explosion of an adjacent mine.

Whether the mines shall be buoyant or ground will depend both upon the depth of water and the character of the bottom. In water of moderate depth and a bottom not too soft a ground mine is to be preferred, since it serves as its own anchor, cannot get adrift, is not easily exploded by an adjacent charge, and is more difficult for an enemy to destroy or neutralize. A buoyant mine, on the other hand, requires a large excess of buoyancy, so that it will remain as nearly stationary as possible over its mooring, to secure which a case must be provided much larger than will hold the required charge. This buoyancy must be increased with the swiftness of the current, so that in strong tideways a buoyant mine is a difficult thing to manage. There is also always a possibility of their breaking from their moorings and going adrift, and thus become a menace to friend quite as much as to foe.

A depth of water of more than 35 or 40 ft. will preclude the use of ground mines, and except in shallow water a buoyant mine would be anchored so as to swing from 10 to 40 ft. below ordinary high-water mark; the distance depending, of course, upon the depth of the channel, the rise and fall of the tide, the size of the mine, and the class of vessel against which it is likely to be used. A first-class iron-clad will draw from 25 to 30 ft. of water, while the smallest war-ship likely to be sent across sea for offensive operations would probably range in draft as low as 10 or 12 ft. The English *Benbow* has a draft of over 28 ft. Some of the earlier built English armored gunboats draw less than 12 ft., and their torpedo vessels of the *Rattlesnake* and *Sharpshooter* type less than 9 ft. The heaviest of the French armored fleet have a draft of nearly 30 ft., while the Italian *Lepanto* and her sister ship, the *Italia*, require 31.2 ft. to float them. Generally speaking, a harbor provided with a good artillery defense would not require the assistance of a system of mines against vessels drawing less than 18 or 20 ft. of water.

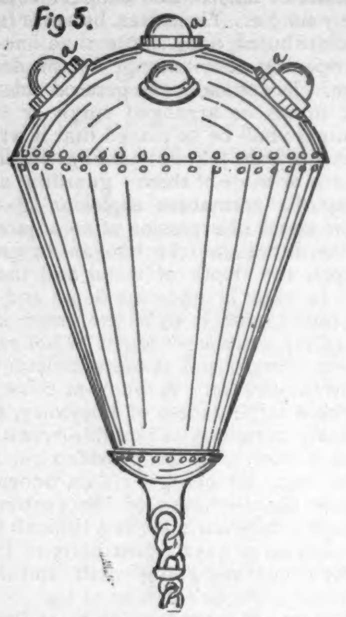
Next to the arrangement of the system comes the question of material, and of the cases in which the explosive is to be placed. These latter must have sufficient strength to resist the pressure of the water and to stand rough handling; they must be absolutely water-tight, although the latter is of less importance if the explosive be gun-cotton or dynamite than if of gunpowder, except as leakage interferes with buoyancy; if for a buoyant mine, the case to be of as light material as the other conditions will admit of. In a gunpowder mine the case should be relatively stronger than in one containing a high explosive, in order to hold the charge together for an instant after ignition, so as to obtain its maximum explosive effect.

The shape of the mine case is not a matter of vital importance. For contact mines the conical or cylindrical form is that usually adopted. For ground mines the English employ hemispherical or dome-shaped cases of cast iron, the flat side resting upon the bottom forming its own anchor. For their buoyant mines they use two or three different patterns of spherical cases, made up of two flanged hemispheres of steel, wrought iron or malleable cast iron, bolted together at the flanges, and packed at the joint with rubber or other like material, or riveted to a narrow metal plate on the inside. This shape is now recognized as the best for a buoyant mine. In their earlier system they used an inner case of thin wrought-iron plate, and to protect this case and provide the necessary buoyancy, enclosed it in a wooden jacket of considerable thick-

ness. It has been found from experiment that the enclosing of the mine case in wood, cork, or other elastic material results in a considerable loss of power.

In our own service buoyant mine cases are constructed of two hemispheres of thin steel, welded together at the

Fig 5.



flanges. For ground mines the turtle-back or mushroom shape is recommended.

An air space that much exceeds in volume three times that of the charge has been found to produce considerable diminution of explosive effect. In all cases the size of the envelope should be kept down to the lowest dimensions compatible with the work required of it.

V.—AUTOMATIC MINES.

Notwithstanding the grave objections that can be urged against the automatic or self-acting mine, from the fact that it will act alike against friend and foe, there are times when, in planning for the defense of a harbor, its use becomes judicious.

If called upon to defend a wide water area, or shallow channels not likely to be used by friendly vessels in war time, these could well be closed with automatic mines; or if called upon to improvise a scheme of mine defense without the time or material necessary for the preparation

Fig. 6.

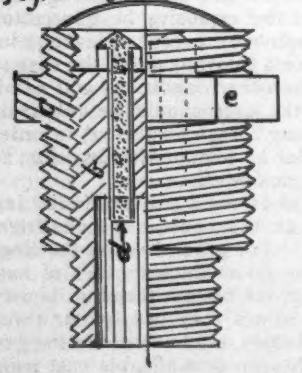
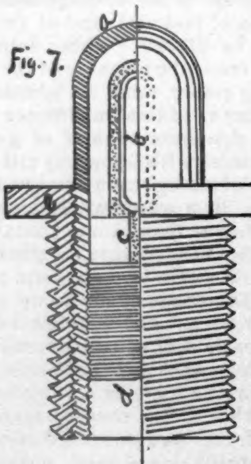


Fig. 7.



of an elaborate system, resort could easily be had to mines of this class.

An automatic mine should, General Abbott says, fulfil three conditions: "(1) That no safety arrangement which requires the act of the planting party to remove is admissible; (2) that some arrangement to cause the immediate explosion of the charge if the mine gets adrift is essential; (3) that every possible means should be taken to make their removal difficult." He adds that upon the latter point there is a wide difference of opinion among engineers.

The Confederates, with no navy to take the sea, with no commerce to be interfered with, if we except the few light draft blockade-runners, could well afford to blockade the entire harbor area of their coast with this class of mines. Some of those devised or improved upon by them remain as types of the best.

The *Automatic Mechanical Mine* was a favorite type with the Confederates. Fig. 5 represents one of the best of this class, the Brooke mine. The case is of metal, conical in shape, and had upon its hemispherical top five fuses. Two varieties of fuses were used with this mine. One, known as the Rains fuse, is shown in fig. 6, half in elevation and half in vertical section. It consisted of an outer cylinder *c*, provided with a thread on its outer circumference for screwing into the mine case; an inner cylinder *b*, carrying the primers *d*, which could be screwed up until the heads of the primers came in contact with the copper cap *a*. The detonating compound was a mixture of fulminate of mercury and ground glass. The hexagonal projection *e* serves for applying a spanner to screw it into the case. The other, shown in fig. 7—the Jacobi chemical fuse—consists of an outer cylinder *e* and an inner one carrying a lead safety-cap. Within this cap was a hermetically sealed glass tube *b*, filled with sulphuric acid, surrounded with a mixture of chlorate of potash and white sugar; *c* is a primer of mealed powder leading to the interior of the mine case. A bending of the lead cap, as

Fig. 8.

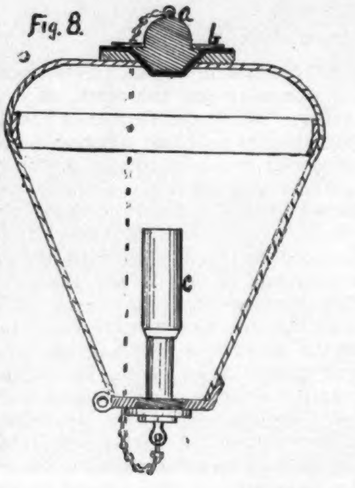
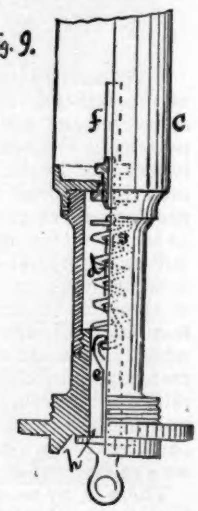


Fig. 9.



from the blow of a passing vessel, breaks the glass tube, when the action of the acid upon the surrounding mixture develops sufficient heat to ignite the mealed powder and so fire the mine.

Another form of the automatic mine is that known as the Singer. In this mine the blow of a colliding vessel displaced an iron cap resting upon the top of its sheet-iron case. This in falling released, by means of a cord or wire, a plunger, which, under the action of a spiral spring, was forced against the fulminating mixture and fired the mine. The McEvoy improved form of this mine is shown in section in fig. 8. The weight *a* rests in a seat upon the top of the case, held temporarily in place by a papier-maché cover *b*, screwed down to the seat. A short submersion in water softens this material and the mine becomes active. The blow from a vessel dislodges this weight, which falling operates the firing mechanism contained in the tube *c*, screwed into the base of the case.

This firing mechanism is shown in elevation and section in fig. 9. Under the action of the falling weight the hook *e* is drawn down, carrying with it the striker *d*, compressing at the same time the spiral spring *s*. As soon as the hook clears the passage *h* the striker is released, flies upward, and in impinging upon the cap of the fuse *f* fires the mine.

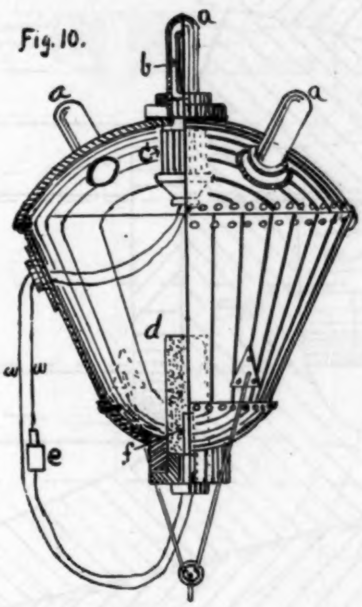
In the Mathieson mine a cylindrical tube is screwed into

a seat on the top of the mine case, containing the firing mechanism. A plunger, weighted with mercury, is suspended at the top of the tube by a vulcanite stem. A powerful blow serves to break this stem when the plunger falls upon a percussion cap, igniting a priming charge, and through it the mine. A disk of zinc confines the mercury to a safety chamber for some hours, long enough for the mine to be planted. The zinc disk is finally eaten away, the mercury descends into the plunger, and the mine becomes active.

The *Automatic Electrical Mine*, as its name indicates, employs an electrical current for igniting the explosive charge, instead of depending upon mechanical means for that purpose, as in the mines just described. A small battery and an electrolyte are provided, so situated that the shock of a colliding vessel brings the electrolyte in contact with the battery, generating a current, and by means of an electrical fuse firing the charge. This mechanism is usually within the mine itself, but may be in a buoy above the mine, or within its anchor.

Fig. 10 shows a Hertz mine with its firing arrangement, half in section and half in elevation. Each of the projecting lead tubes, *a*, of which there are five, contains a chlorate of potash mixture enclosed in a glass tube. Beneath is a brass case containing several pairs of carbon and zinc

Fig. 10.



plates, forming a cell *c*. Two insulated wires, *w*, lead into the case, one connected with the zinc terminals of the five cells, the other with the five carbon terminals. The other extremities of these wires are connected with the electrical fuse *f*, embedded in the priming charge *d*. The crushing of the glass tubes precipitates its contents into the cell beneath, excites a current and ignites the fuse. As a means of safety the lead tubes are, until the mine is planted, covered with brass cylinders, and one of the wires is provided with a key *e*, which is closed when the mine is to be rendered active.

In the McEvoy mine a weight is dislodged, as in the Singer type of mine, which breaks the glass tube containing an electrolyte, and the action is the same as in the case just described. In the English naval mine two small Leclanché cells are enclosed within the mine, their terminals leading through a circuit-closer to an electrical fuse. This circuit-closer consists of a metal cup partly filled with mercury. One wire is in contact with the mercury, the other with a stem projecting into the cup and a short distance from the surface of the mercury. A violent blow throws up the mercury, closes the circuit, and ignites the fuse.

(TO BE CONTINUED.)

THE NEW YORK AND NEW JERSEY BRIDGE.

At a meeting of the Commissioners of the New York & New Jersey Bridge held December 2, a report was presented on the proposed structure. The plans for the bridge cannot be completed until the War Department gives its decision fixing the height and length of span for the bridge, as it is required to do under the act authorizing the bridging of the Hudson River. The location adopted by the Commissioners is given in the report as follows:

Beginning at a point in New Jersey on the west side of the Hudson River, between the lines of Seventieth and Seventy-first streets, in the city of New York, produced; thence running easterly between Seventieth and Seventy-first streets to a point near Eleventh Avenue; thence curving to the south and running about 100 ft. west of the west line of Eleventh Avenue to such a point as far north of Thirty-eighth Street as will allow of a curve of proper radius; thence curving to the east and running between Thirty-eighth and Thirty-ninth streets to a union station, which union station will cover the blocks between Thirty-seventh and Thirty-ninth streets, and extend from Eighth Avenue to Broadway.

One approach to extend from said union station in diagonal line to a connection with and for the Manhattan Elevated Railroad on Sixth Avenue at or near Thirty-third Street.

Another approach will run from the west end of the said Union Station at Eighth Avenue with a two-track line descending toward the Hudson River in the lower part of the viaduct above the New York Central & Hudson River Railroad tracks lying between Sixtieth and Seventy-second streets, and will descend to a level of about 8 ft. above the mean high tide in the Hudson River at or near Seventy-ninth Street. Thence it will run along the river front outside of the present New York Central & Hudson River Railroad tracks upon a pile foundation, or filling, or both, to be made for it. Near One Hundred and Fifty-fifth Street it will rise over the New York Central & Hudson River Railroad tracks and curve to the east into a tunnel about half a mile long at or near One Hundred and Fifty-fifth Street, coming out on the east side of the hill and crossing at a clear elevation of 18 ft. above the tracks of the Manhattan Elevated Railroad at or near One Hundred and Fifty-fifth Street; thence across the Harlem River in a northeasterly direction to a connection with and for the New York & Northern and the New York Central & Hudson River railroads, opposite or nearly opposite One Hundred and Sixty-second Street prolonged. Thence substantially by a direct line to a connection with and for the New York & Harlem Railroad, at or near One Hundred and Sixty-second Street. Thence along the easterly side of the Spuyten Duyvil & Port Morris Railroad to Long Island Sound, and to a connection with and for the Harlem River & Portchester Branch of the New York, New Haven & Hartford Railroad. Connections will be made with all intersecting railroads. Stations to be erected at all connections with railroads, and also at or near Seventy-second Street, Eighty-sixth Street, Manhattan Street, and One Hundred and Fifty-fifth Street.

THE HUDSON RIVER IMPROVEMENT.

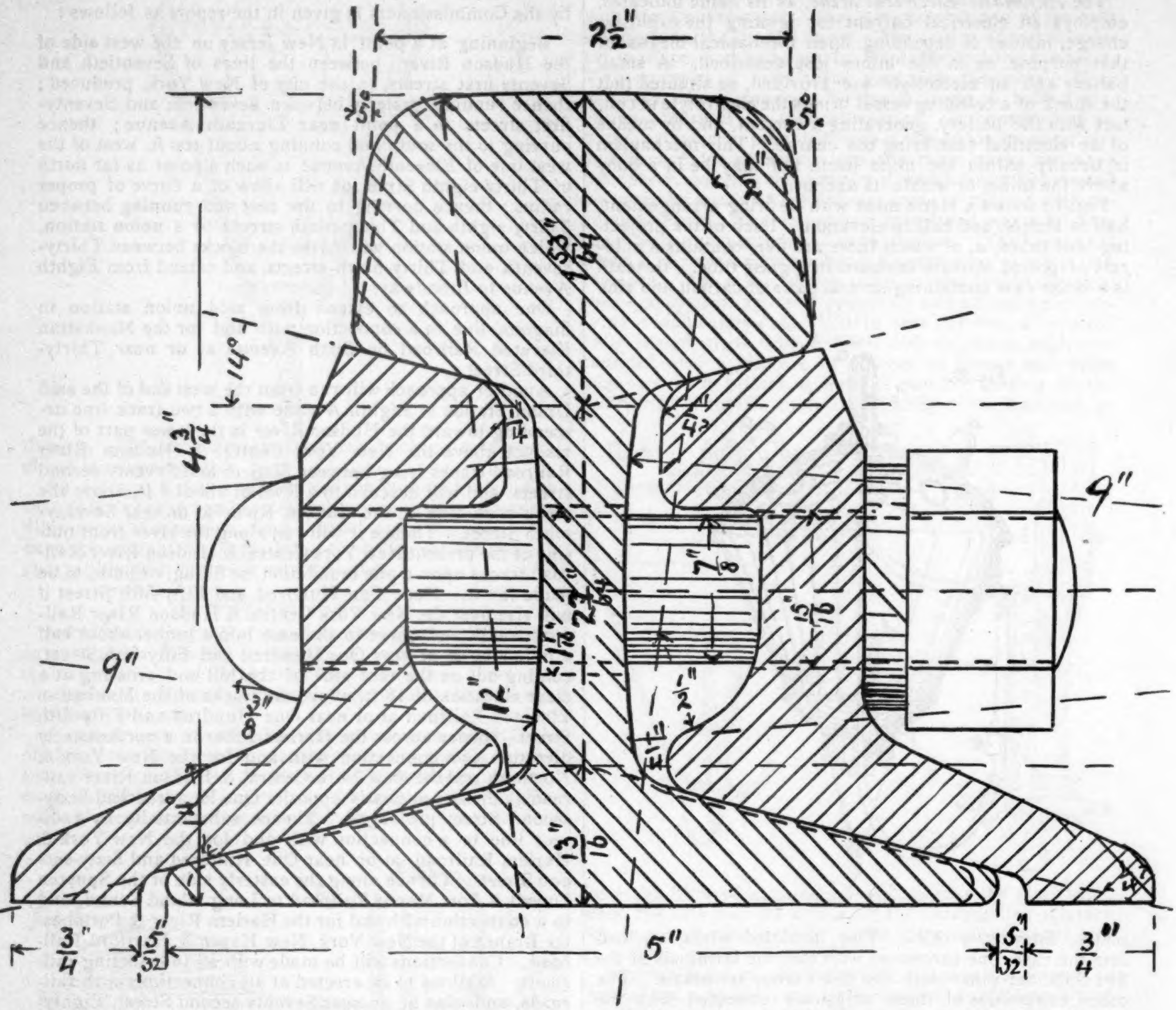
An examination is now being made of the channel of the upper Hudson, with a view to estimating the cost of deepening it, so as to enable vessels drawing 20 ft. of water to go up the river to Albany and Troy. At present there is deep water in the Hudson as far as Coxsackie, about 120 miles from New York. From that point to Albany the channel is narrow and crooked, but considerable sums of money have been spent upon it from time to time, both by the State of New York and the United States. The existing channel, which is maintained by dikes and by frequent dredging, is 11 ft. in depth and 175 ft. in width from Coxsackie to Albany, about 28 miles. From Albany to Troy, 5 miles further, it is 10 ft. in depth and 140 ft. in width. The deepening of the channel to 20 ft. will require

the removal of several bars with a good deal of diking, and possibly the cutting of an entirely new channel at one or two points, but will be of great benefit to navigation.

Perhaps the widening of the channel would be more beneficial than an increase in depth. The number of tows coming from the canal at Albany is very large, and in the present condition of the river there are several points where passing two such tows is not an easy matter. Much injury is done to the channel by heavy ice in the winter and spring, which damages and sometimes breaks through the dikes, and aids in forming bars and obstructions.

THE LEHIGH VALLEY STANDARD 80-LBS. RAIL.

The accompanying illustration shows a section of the 80-lbs. steel rail recently adopted as a standard by the Lehigh Valley Railroad Company. It replaces a 76-lbs. rail, the section of which is shown by the dotted lines which come inside the full lines showing the new section. It will be seen that the additional metal has been placed partly in the head, increasing its width somewhat, and partly in the foot of the rail, which is slightly wider in the new than in the old section. The corners of the head, it will be seen, have one-half inch radius, as heretofore, while the metal in the stem has not been increased.



NEW STANDARD 80-LBS. RAIL, LEHIGH VALLEY RAILROAD.

The same joint is used for the new as for the old section. This Company has for two years past adopted the plan of cutting the ends of the rails miter, or at an angle of 45°, and this plan has worked so well that there is no disposition to abandon it. The advantages found are in the absence of jar at the joints and also in the absence of cutting or excessive wear at the ends of the rails.

A number of these rails recently made have been rolled 45 ft. in length instead of 30 ft., thus saving 33 per cent in the number of joints. About a mile and a quarter of track has been laid with the 45-ft. rails.

This new section illustrates the tendency to use a heavier rail on all roads of large traffic, and it also shows where the experience of this road has proved that additional metal can be applied to the best advantage.

Recent Patents.

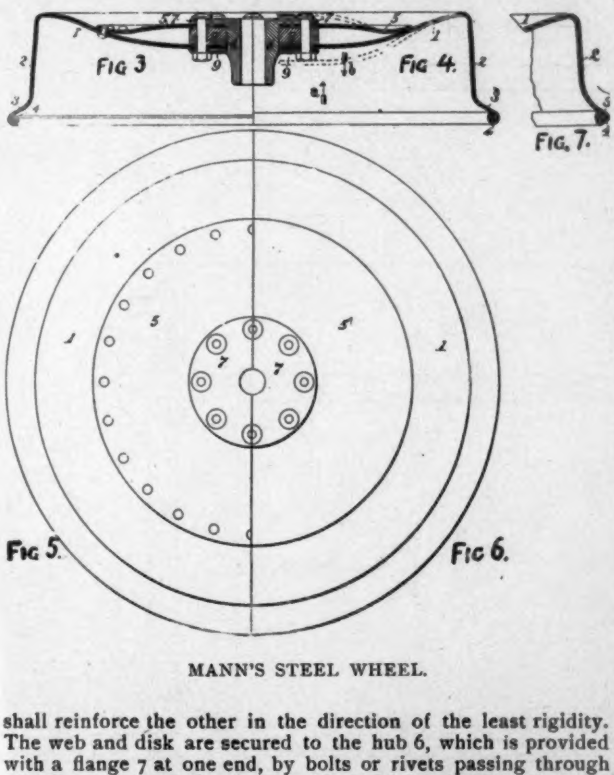
MANN'S CAR-WHEEL.

Figs. 3–7 show a form of car wheel covered by patent No. 433,950, issued recently to Henry F. Mann, of Allegheny, Pa. In the illustrations, fig. 3 is a sectional view of one-half of a car-wheel embodying this invention; fig. 4 is a similar view of a modified form of the wheel; figs. 5 and 6 are views in side elevation of the wheels shown in figs. 3 and 4, respectively; and fig. 7 is a sectional detail of a further modification.

In practice the edge of a circular disk 1, of suitable dimensions is turned over to or approximately to a right angle to the body of the disk, said turned-over portion being of sufficient width for the formation not only of the tread 2 and flange 3, but also for the formation of a bead along the edge of the flange, which is formed by bending outwardly the edge of the portion turned over in forming the tread 2.

In forming the flange 3 metal of a width greater than that required for the flange should be bent outwardly, as above stated. This excess of metal is then bent over a ring 4, formed of heavy wire or wire rod. The metal inclosing the wing 4 may extend only partially around the wire, as shown in fig. 3, may be made to entirely embrace the ring, as shown in fig. 4, and the wire, wire rod, or tube forming the ring 4 may be round in cross-section, as shown in figs. 3 and 4, or angular, as shown in fig. 5, or it may be tubular, as the uses to which the wheel is to be put may require. It will be observed that by bending the metal over the wire the flange of the wheel is made sufficiently wide or thick to properly guide the wheel in passing over frogs, switches, and crossings—a function which this class of wheels as now constructed of a single thickness of metal does not properly perform.

In order to reinforce the web, which is dished, as shown, to enable it to better endure the strains of service, a concavo-convex metal disk 5 is secured to the web by rivets, as shown in fig. 4. The disk is arranged with its convex surface outward—that is to say, the disk is so placed that the concave surfaces of the disk and web shall be adjacent to each other, so that one



MANN'S STEEL WHEEL.

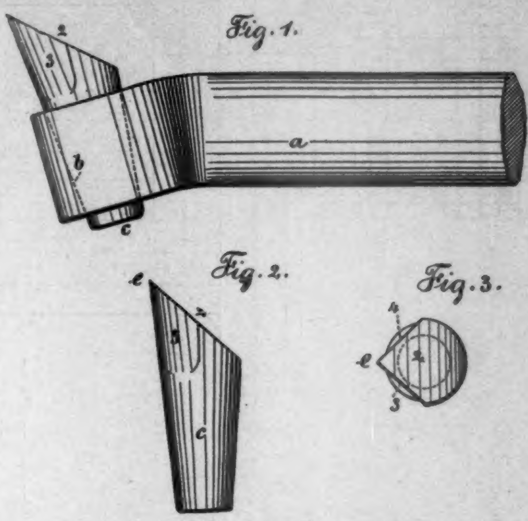
shall reinforce the other in the direction of the least rigidity. The web and disk are secured to the hub 6, which is provided with a flange 7 at one end, by bolts or rivets passing through said flange, an annular distance-block 8 interposed between the disk and web, and a washer 9, arranged outside of the web or disk.

In lieu of securing the disk to the web by rivets, as shown in figs. 3 and 5, the web and disk may be made with a deeper dish, as indicated by dotted lines in fig. 4, than required to obtain the relative adjustment of the disk and web, as shown in fig. 3, so that when said parts are placed together, with the edges of the disk resting upon the web, the distance between the two will be greater than desired in the finished wheel, and considerable power will be required to draw them into proper relation on the hub. It will be obvious that when so drawn into position the disk and web will bear against each other with a pressure proportional to the force required to bring them into the desired relation, and being under a strain will offer a more prompt and greater resistance as against lateral strains—as, for example, in the arrangement of the disk and web shown in fig. 4, the web will resist any outward strains in the direction of the arrow *a*, while the disk 5 will operate similarly as against strains in the direction of the arrow *b*.

This invention is also readily applicable to wheels wherein the web and tire are formed independent of each other and secured together by bolts or other suitable means.

BUSSELL'S TURNING TOOL.

The accompanying illustrations show a very neat and simple tool and tool-holder, which are protected by Patent No. 429,883, issued to Edward Bussell of New York. The tool-holder has a tapering eye, while the tool has a tapering shank made to fit

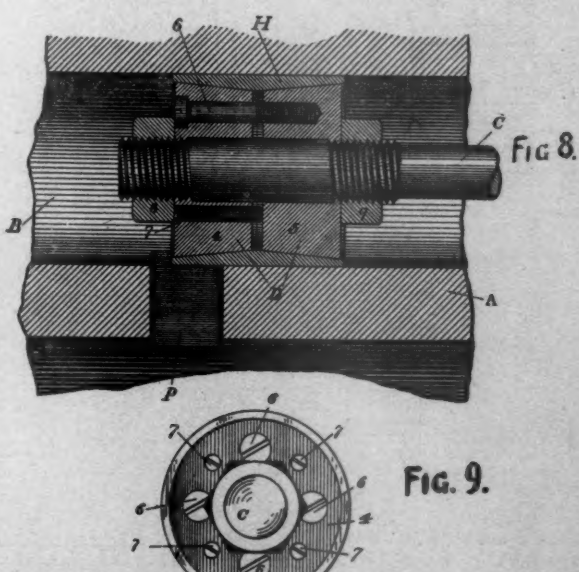


BUSSELL'S TURNING TOOL.

the eye, the end and side being ground off to form the cutting edge. Fig. 1 is an elevation of the tool and holder; fig. 2 a detached view of the tool, and fig. 3 an end view of the same. The holder is made of a bar *a* with an eye *b* at one end made tapering to receive the tapering shank *c* of the tool. At the end of the tool-shank *c* is the cutting edge *e*, formed of the inclined faces 2 and the side faces 3 4, ground to form a sharp cutting edge. The shank *c* wedges tightly into the eye *b*, but can be easily separated by a tap of the hammer on the smaller end and turned around into any desired position. In the same way a dull tool can be very easily removed and a new one substituted.

RICHARD'S PISTON-VALVE.

Figs. 8 and 9 show a form of piston-valve covered by patent No. 430,484, issued to Francis H. Richards, of Hartford, Conn.



RICHARD'S PISTON VALVE.

Fig. 8 is a section and fig. 9 an end view. In fig. 8 the letter *A* shows part of a cylinder, in which the valve-seat *B* is bored. The valve-stem *C* has upon its outer end a core *D*, consisting

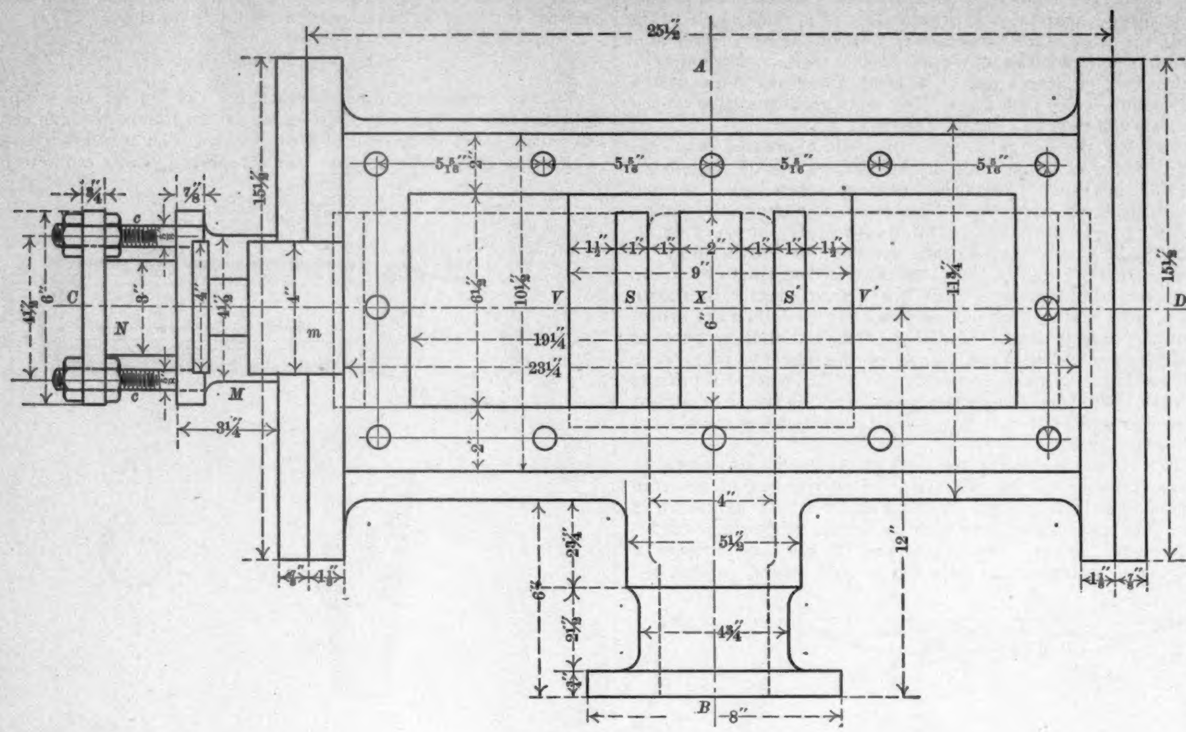


Fig. 207.

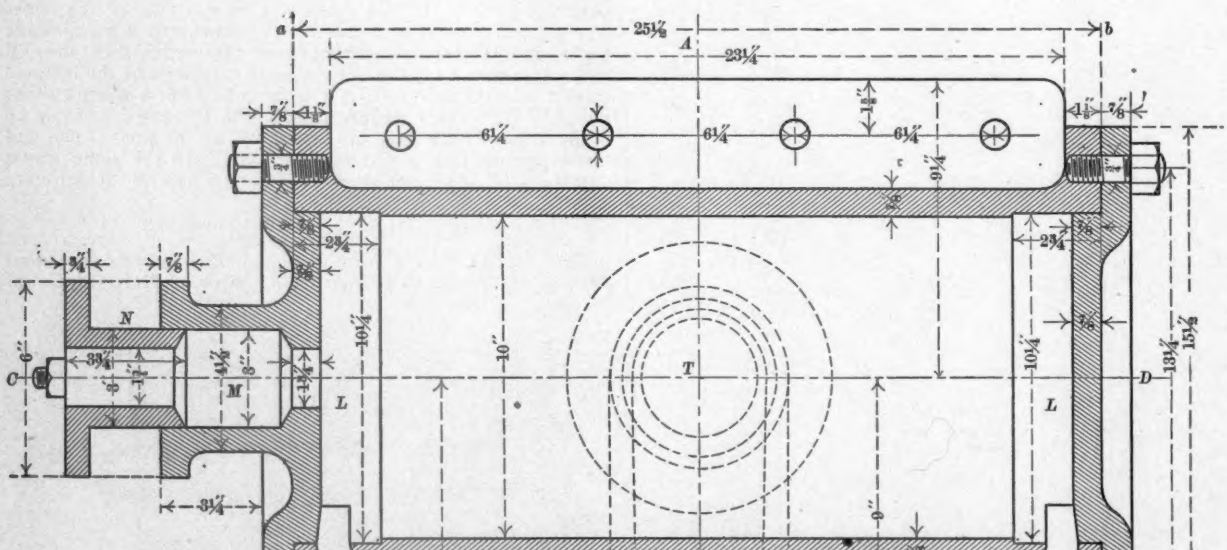


Fig. 208.

STEAM ENGINE CYLINDER. SCALE, 2 IN. = 1 FT.

of two parts 4 and 5, made coned or tapering inward toward each other. Surrounding these two cones is a shell *H*, having its bore or central opening tapering from both ends inward, so that there are within the shell two conical portions corresponding in shape with and adapted to be engaged by the peripheries of the two cones 4 and 5, forming the core *D*. The conical portions of the interior of the shell are, however, as shown in the drawings, made to taper down to a diameter less than that of the inner ends of the cones. Screws 6 6, passing through the outer cone 4 and tapped into the other one, serve to draw or force the two cones toward each other, while screws 7 7, tapped through the outer cone 4 and at their inner ends engaging cone 5, are employed to force and hold the cones apart. By means of the two sets of screws the cones can be adjusted to any desired distance apart and fixed as adjusted.

The core *D*, formed of the two adjustable cones, as described, is held in place on the valve-stem *C* by means of the nuts 8 and 9, screwed on the stem and engaging the ends of the outer and inner cones, respectively. With the core thus held by the nuts it can be not only securely fastened in place on the stem, but also adjusted as desired along the latter to change the position of the valve. The opposite ends of the shell *H* are preferably made of the same thickness where, as in motor engines, both ends of the piston-valve are alternately used to cut off air from port *P*.

The material of which the shell is made should be one having elasticity, or being capable of expansion and contraction without any slotting or division of the shell. The materials found in practice to be suitable for the shell are soft steel, bronze or cast iron, while for the core *D* steel is used. The taper of the cones and of the conical portions of the bore of the shell is made slight or at a small pitch, and that of either of the cones and the respective surface within the shell to be engaged by the cone is preferably made of the same pitch or at the same angle.

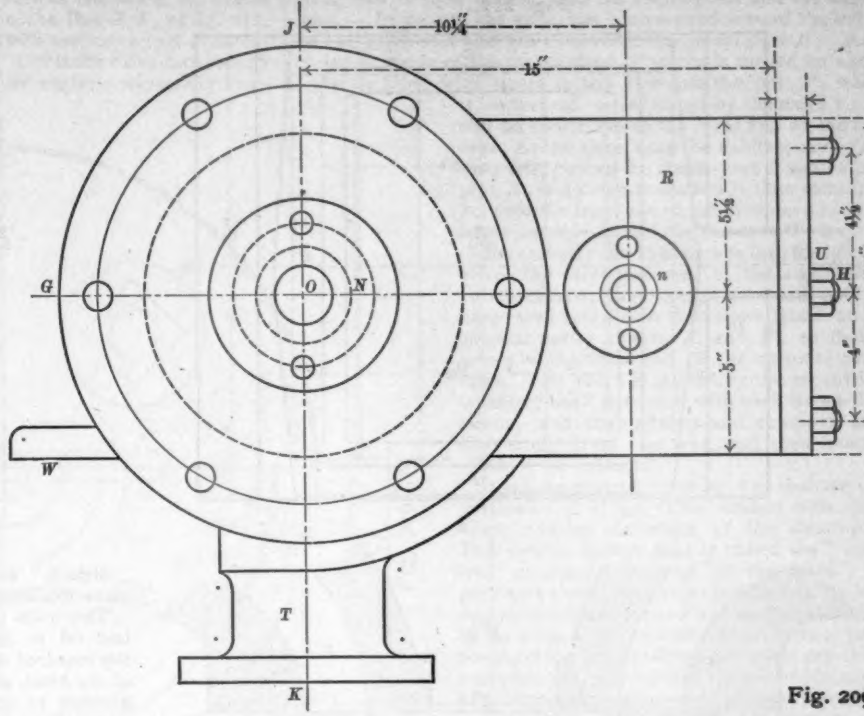


Fig. 209.

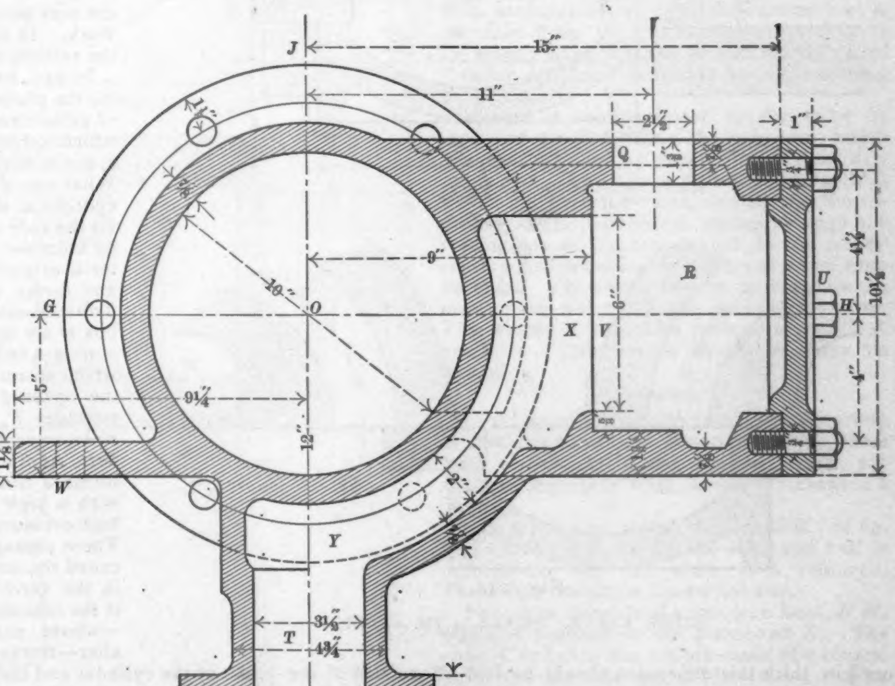


Fig. 210.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page 570, Volume LXIV.*)

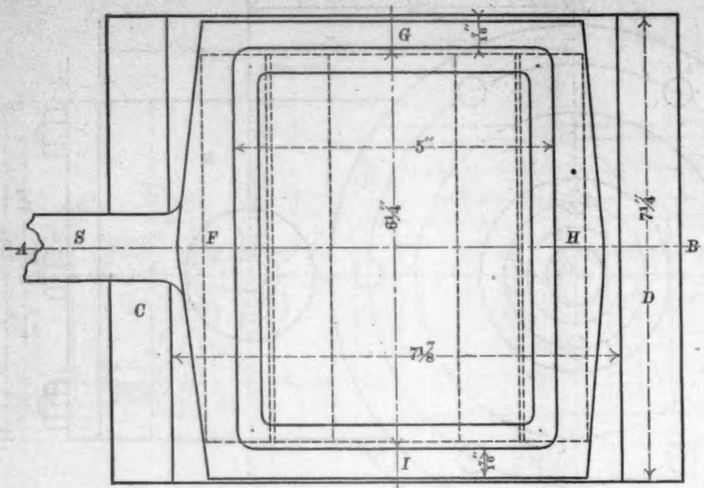
CHAPTER VII.—(*Continued.*)

THE STEAM-ENGINE.

CYLINDER.

Fig. 207 is a side view of a cylinder, with the cover of the steam chest removed; fig. 208 is a sectional plan drawn through the center of the cylinder; fig. 209 is a back end view, and fig. 210 is a transverse section on the line *A B* of figs. 207 and 208. These figures should be drawn half or quarter size. In drawing figs. 207 and 208 longitudinal center lines *C D*, *C D* should first be drawn. Vertical lines *A B*, *A B* passing through the middle of the cylinder should then be laid down. In figs. 209 and 210 horizontal center lines *G H*, *G H* and vertical lines *J K*, *J K* should form the base lines, from which other dimensions may be laid off. The inside diameter of this cylinder, as shown in figs. 208 and 210, is 10 in. Owing to the limited size of the pages of the Journal, figs. 207 and 209 and figs. 208 and 210 had to be placed opposite to each other. In drawing these the student should lay them all down on one sheet of paper, and the centers *O* and *O* should be in the center lines *C D* and *C D* extended. To begin with, circles 10 in. in diameter should be drawn from the intersections *O*, *O*, of the horizontal center lines *G H*, *G H*, figs. 209 and 210, with the vertical lines *J K*, *J K*, to represent the inside of the cylinder. As the sides of the cylinder

Fig. 211.



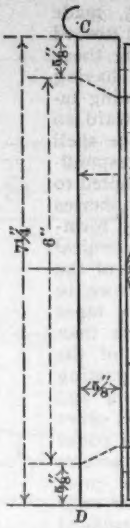


Fig. 212.

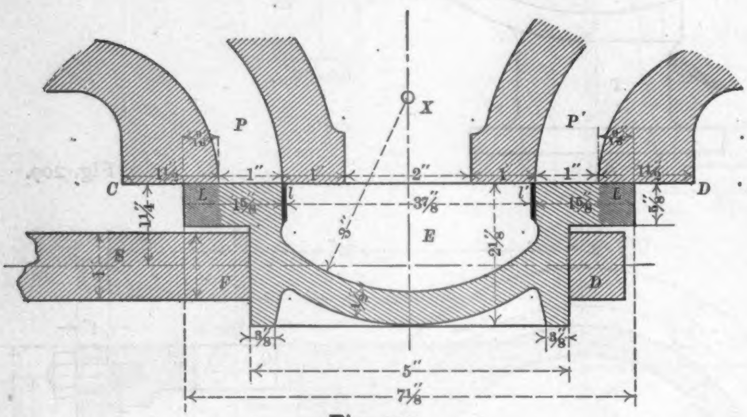


Fig. 213.

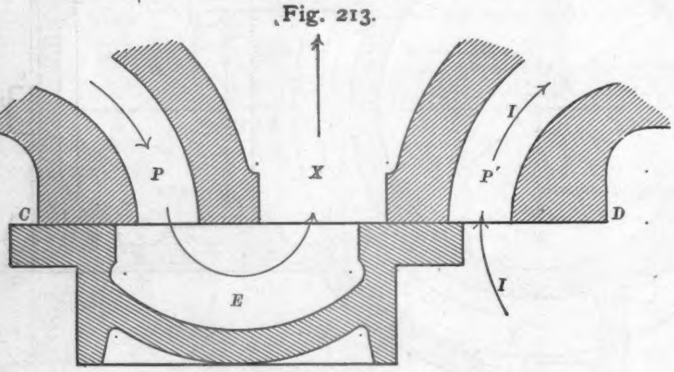


Fig. 214.

SLIDE VALVE. SCALE, 4 IN. = 1 FT.

"dished," as shown, the central part being the same thickness, $\frac{5}{8}$ in., as the outer rim.

The bolts or studs in the cylinder-heads are laid off in figs. 209 and 210 by drawing a circle the required distance inside of the circumference of the head, and then dividing it into the required number of spaces, in this case six. In figs. 209 and 210 the bolts are represented by circles only, the nuts being omitted. This is often done to save work. In fig. 208 the studs and nuts are shown in the section, and thus give all their dimensions.

In figs. 207 and 208 *M* and *m* are stuffing-boxes for the piston-rod and valve-stem. They consist of cylindrical-shaped openings *M* and *m*, fig. 208, which surround the rod and valve-stem. This space is filled with hemp or other fibrous material. What are called glands, *N* and *n*, which are hollow cylindrical-shaped pieces of metal, are then placed on the rods and are forced into the stuffing-boxes by bolts and nuts, *c c*, fig. 207. The fibrous material or packing, as it is called, is thus compressed and forms a steam-tight joint around the rods. To avoid confusion the bolts in the smaller stuffing-box *m* are not shown in the drawing.

R is a box or receptacle called a *steam-chest* to which steam is conducted by a pipe attached to the opening *Q*, fig. 210. From the steam-chest passages *P*, *P*, fig. 208, called *steam-passages* or *steam-ways*, communicate to each end of the cylinder. Another passage, *X Y*, figs. 208 and 210, forms a communication from the steam-chest *R* with a pipe *T*, called the *exhaust-pipe*, which, in high-pressure engines, is open to the atmosphere. These passages terminate in a flat surface *V V*, called the *valve-face*. The openings *S S*, fig. 207, in the valve-face, are called steam-ports, and *X* is the exhaust port. On this surface a slide-valve —whose construction will be explained hereafter—works, and alternately admits steam to one end of the cylinder and then to the other through the passages *P* and *P*, and also allows it to escape through the same channels and the exhaust-passage *X Y*. These passages are all cast with the cylinder and are of somewhat complicated form, so that the student will be obliged to study the engravings carefully to understand their shape and position. If he can examine a cylinder casting he will be able to understand them better than he can from an engraving alone. It is doubtful whether further explanation will aid him in getting a clearer understanding of the construction of a cylinder.

The steam-chest in the present illustration is cast with the cylinder and forms a part of the same casting. The cover *U* is bolted to the chest by the studs which are clearly shown in the engraving. The flange *W* is for fastening the cylinder to the engine-frame. The bolts *f*, *f*, represented by dotted circles in fig. 208, are also for fastening the cylinder to the frame.

are $\frac{3}{4}$ in. thick this dimension should be laid off outside of the circle, another circle should be drawn with a radius of $5\frac{3}{4}$ in. from the center *O* through the point thus laid down. Then with the T-square lines can be projected in fig. 208, which will represent the inside and the outside of the cylinder. The length of the cylinder, as indicated by the dimension *a b*, fig. 208, is $25\frac{1}{2}$ in. This should be laid off from the line *A B*. The diameter of the flanges and the cylinder-heads is $15\frac{1}{2}$ in. Circles of this diameter, drawn from the centers *O*, *O*, figs. 209 and 210, will represent the heads and flanges. From the circumference of these circles lines can be projected with the T-square and drawn in figs. 207 and 208 to represent the outline of these parts. Their thickness, $1\frac{1}{4}$ and $\frac{5}{8}$ in. respectively, can then be laid down in the figs. last referred to and lines drawn to represent it.

In boring steam-engine cylinders they are usually bored larger at each end, so that the piston will move slightly beyond the smallest part of the bore. This enlarged part is called the *counterbore*, and is shown at *L* and *L'* and is $\frac{1}{8}$ in. larger in diameter than the other portion of the inside of the cylinder. The depth of the counterbore is $2\frac{3}{8}$ in. and is shown in fig. 208. The cylinder-heads, it will be seen, are made to project into the ends of the cylinders $\frac{1}{8}$ in. The heads are made

SLIDE-VALVE.

The slide-valve for the engine, which has been illustrated by the preceding engravings in this chapter, is shown by figs. 211–214. These engravings should be drawn by the student either

half or full size. Fig. 211 is a side view of the valve, fig. 212 an end view, fig. 213 a sectional plan on the line *A B*, of fig. 211, and fig. 214 is another similar plan with the valve in a different position from that shown in fig. 213. *C D* is the valve-face, which in this case stands vertical. In many engines, especially loco-

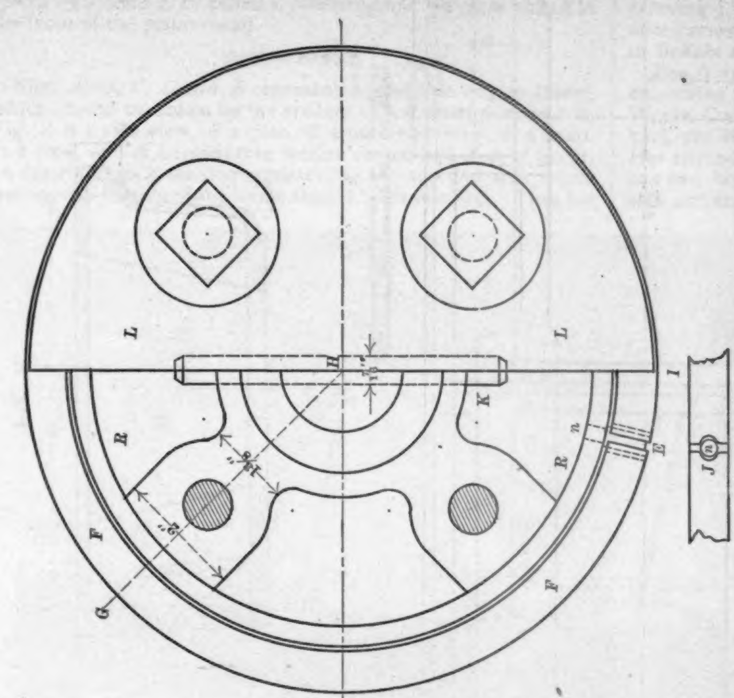


Fig. 216.

PISTON. SCALE, 4 IN. = 1 FT.

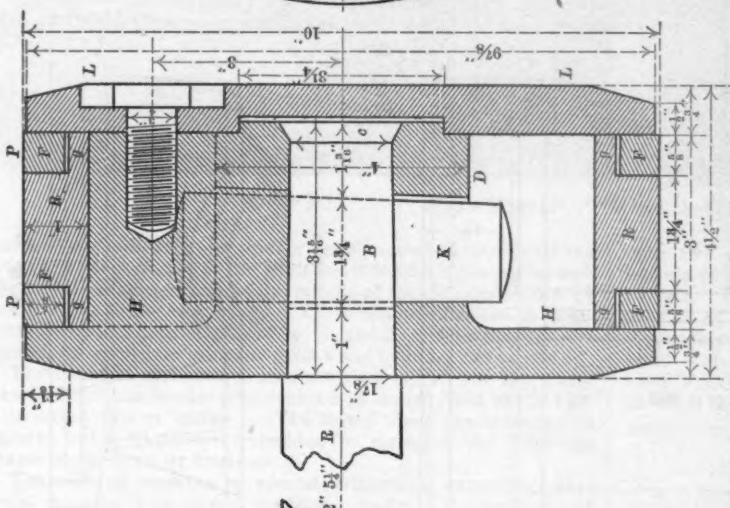


Fig. 215.

motives, it is usually placed horizontal. *P P'* are the steam and *X* the exhaust-passages. The openings where these emerge into the valve-seat are called *steam* and *exhaust-ports*.

The action of the valve may be readily understood from figs. 213 and 214. In fig. 213 the valve is shown on the middle of its seat, and it then covers both the steam-ports and the exhaust-port. In fig. 214 the valve has been moved toward the left side of the valve-seat and has uncovered the steam-port *P'*. As the valve is inside of the steam-chest, if steam is turned on and the chest is filled with steam it will flow into the port *P'*, when it is uncovered, as indicated by the darts 1 1, and will be conducted to the front end of the cylinder. At the same time the exhaust cavity *E*, in the valve, covers the steam-port *P* and exhaust-port *X*, and communication is thus established between the front end of the cylinder and the exhaust-passage *X*, and the steam in the front end of the cylinder can thus escape into the open air. When the valve is moved to the right the reverse action occurs—that is, the steam-port *P* is uncovered and steam then flows into it and the exhaust-cavity covers *X* and *P'*, so that the steam in the front end of the cylinder can escape. The valve is moved by the eccentric alternately back and forth with each stroke of the piston, and thus admits and exhausts steam alternately from one end and then from the other of the cylinder.

It will be noticed from fig. 213 that the outer portions *L L* of the valve, shaded with double lines, overlap the edges of the steam-ports. This double shaded part is called the "*outside lap*," or simply the "*lap*" of the valve. This performs a very important function in its working, as it covers the parts and encloses the steam in the ends of the cylinder and allows it to expand during the time that the ports are closed, and until they are opened by the inside edges *l* and *l'* and the steam is then allowed to escape.*

In order to prevent both of the steam-ports from communicating with the exhaust-port at the same time, the inside edges of the valve *l l'* usually have a small amount of lap called "*inside lap*," and indicated by black shading in the fig.

Motion is communicated to the valve by means of a rod *S*, called the *valve-stem*, which has what is called a "*yoke*," *F G H I*, fig. 211, on its end. This has a square opening in it which fits over the valve, as shown in the engraving. The valve-stem passes through the stuffing-box *M*, fig. 207 and 208, in the steam-chest, which prevents the leakage of steam from the chest. The dotted lines in fig. 212 show the form of the cavity *E* in the inside of the valve. The weight of the valve rests on a slide *D K* below it. This serves merely to carry its weight.

PISTON.

In the construction of pistons a great variety of methods have been adopted to make them work steam-tight in the cylinder. Figs. 215 and 216 represent what is called Stevenson's packing.

Fig. 215 is a section on the line *G H I* of fig. 216, and in the latter fig. the left hand half is represented with the plate *L L* removed. These figs. should be drawn full size.

The piston consists of a cast-iron head, *H H*, which is fastened to the piston-rod *R*. The ends *A* and *B* of the rod are made of a conical form, and the one end *B* fits into a similar shaped hole in the piston-head. This end of the rod is riveted, as shown at *c*, to hold the piston-head on the rod. Besides the riveting a tapered key *K* passes through the boss *D*, and the rod so as to hold the piston-head securely to the rod. The other end, *A*, of the rod fits into the cross-head, as shown in figs. 203–205.

A solid cast-iron ring, *R R*, with grooves *g g* in it, encircles the piston-head. Two other smaller rings, *F F*, called *packing-rings*, are placed in the grooves *g g*. The outside diameter of these packing rings is made somewhat larger than the inside of the cylinder, and they are then each cut apart transversely, as shown at *E*, fig. 216. This permits them to be sprung together so as to enter the cylinder, and their elasticity then causes them to expand and fit the cylinder. An inverted plan

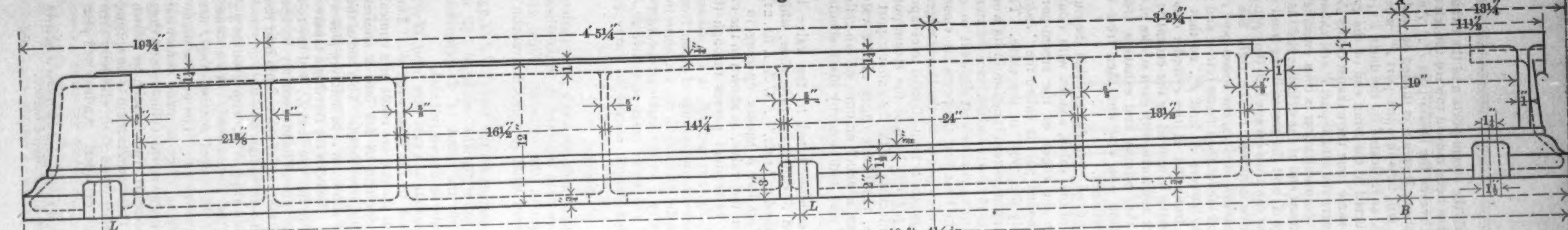
* For a fuller explanation of the action of a slide-valve the reader is referred to the Author's "Catechism of the Locomotive," Second Edition.

PLATE I.

ENGINE FRAME.

SCALE 1 IN. = 1 FT.

Fig. A.



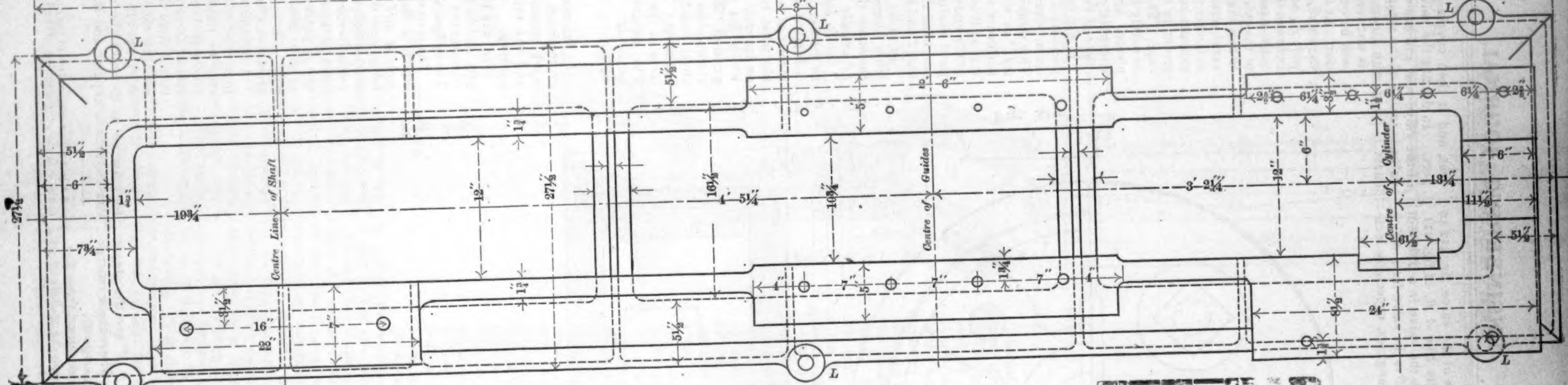


Fig. B.

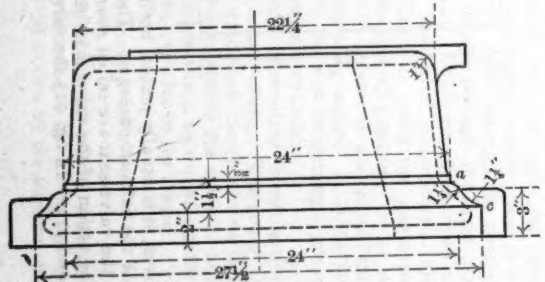


Fig. C.

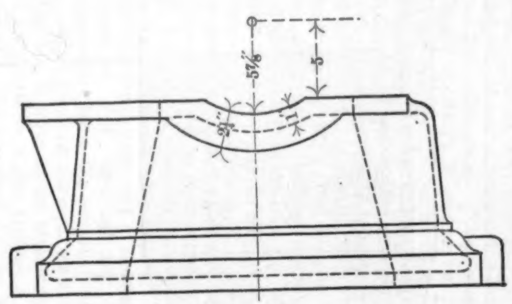


Fig. D.

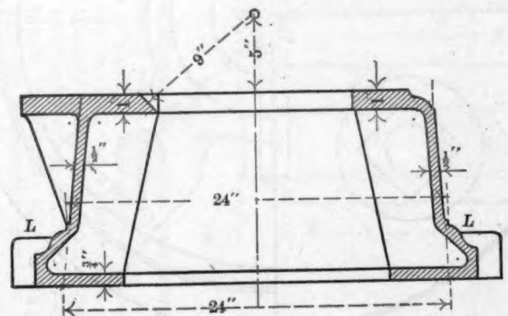


Fig. E.

of the packing ring, where it is cut apart, is shown at *J*. A small pin *n* is attached to the ring *R* and prevents the ring *F* from turning.

The solid ring *R* and the two packing rings are held in their places by a plate *L L*, called a *follower-plate*, which is bolted to the front of the piston-head.

ENGINE-FRAME.

Figs. *A*, *B*, *C*, *D* and *E* represent a cast-iron engine-frame, which should be drawn by the student to a scale of 3 in. = 1 ft. Fig. *A* is a side view, *B* a plan, *C* a back-end view, *D* a front-end view, and *E* a transverse section on the line *A B* of fig. *A*. In drawing fig. *A* the line representing the top and that representing the bottom of the frame should be drawn first. Then lay out the longitudinal center line for the plan, and on this locate the transverse center lines of the shaft and that which passes through the middle of the guides and the middle of the cylinder shown by dotted lines in the engravings. These can be extended to intersect the top and bottom lines of fig. *A*, and from them the lugs and flanges to receive the pedestal guides and cylinder can be laid off.

The frame is cast hollow, as shown by fig. *A*, but has transverse ribs on the inside—represented by dotted lines in the figs.—to strengthen or stiffen it. The lugs *L L*—*L* are intended to receive bolts, which are imbedded in masonry and hold the frame securely to its foundation.

The drawing presents no special difficulties, excepting, perhaps, the moulding around the base. In fig. *C* the vertical and horizontal width of the members of this moulding are shown. Lay these down and unite the points *a* and *c* with a straight line. Subdivide this line and then draw in the curves, as explained in Problem 64.

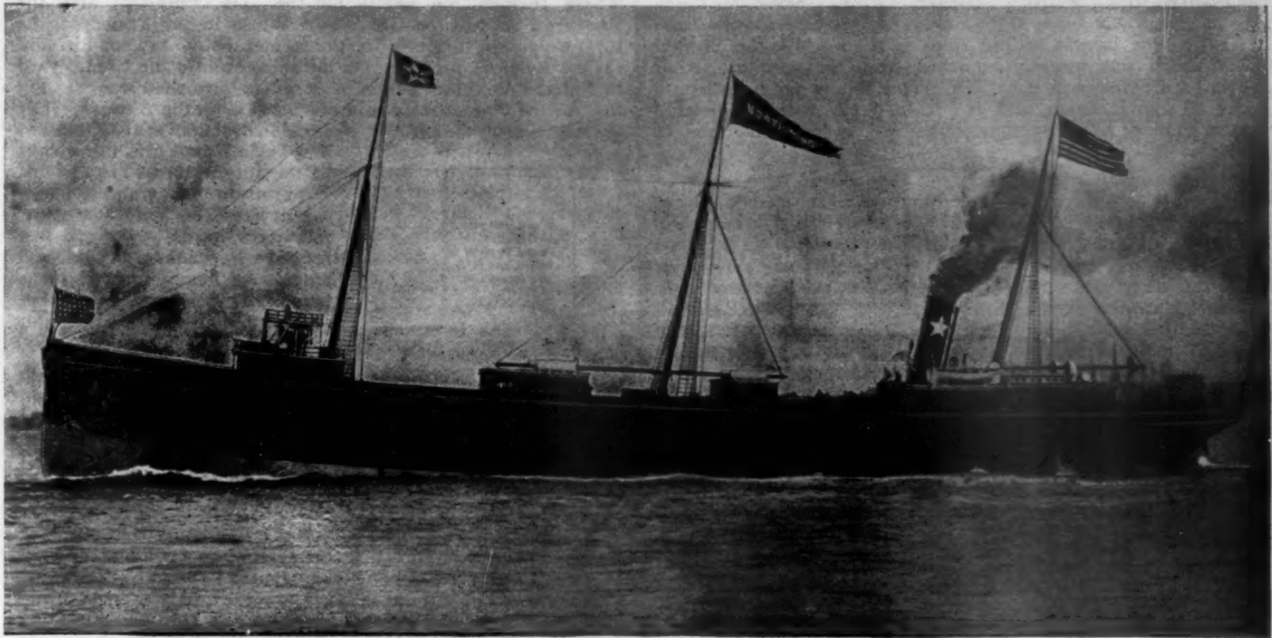
(TO BE CONTINUED.)

The Business Boat of the Lakes.

(From the Cleveland *Marine Review*.)

A LIKENESS of the propeller *North Wind*, which accompanies this, is a fair representation of the business boat of the lakes. The *North Wind* is one of a fleet of six steel steamships, owned by the Northern Steamship Company, the lake line of the Great Northern Railroad Company between the head of Lake Superior and seaboard connections at Buffalo. As this fleet will have carried between the opening and close of navigation 500,000 tons of freight including 1,300,000 barrels of flour, they may well be classed among the money makers, and the immense tonnage credited to them shows the extent of the lake trade outside of the millions of tons in the coal and ore business. But they are unable to meet requirements even in connection with the railroad, and preparations are being made for increasing the fleet in the near future by an addition of four steamers, two of which will, in all probability, be passenger steamers, elegantly equipped and so arranged that they can be used for freight traffic when the passenger season is over, carrying 3,500 tons of freight through the Sault Canal. President James J. Hill, of the Great Northern Company, is expected in Buffalo shortly to consider the matter of new boats.

The *North Wind*, like the other boats of this fleet—they are duplicates in every respect and were built by the Globe Iron Works Company—cost her owners $223,000. She is 292 ft. keel, 312 ft. over all, 40 ft. beam, and 24½ ft. moulded depth. Her triple-expansion engines are 24, 38, and 61 by 42, and she has two boilers 14 × 12½ ft. She has four gangways on either side and six hatches for the handling of freight. A line shaft with two drums to each hatch enables the boat to handle 96 barrels of flour at one time, as each of the drums handle eight barrels. The boats are capable of carrying about 2,500 net tons on 15 ft. of water through the Sault Canal. The boats are thoroughly equipped in every way, the *Northern Wave* being fitted with an Edison electric light plant, and the entire fleet have Providence windlasses. Electric plants will be placed on all of the other boats of the line during the coming winter.



STEAMSHIP "NORTH WIND."

Manufactures.

General Notes.

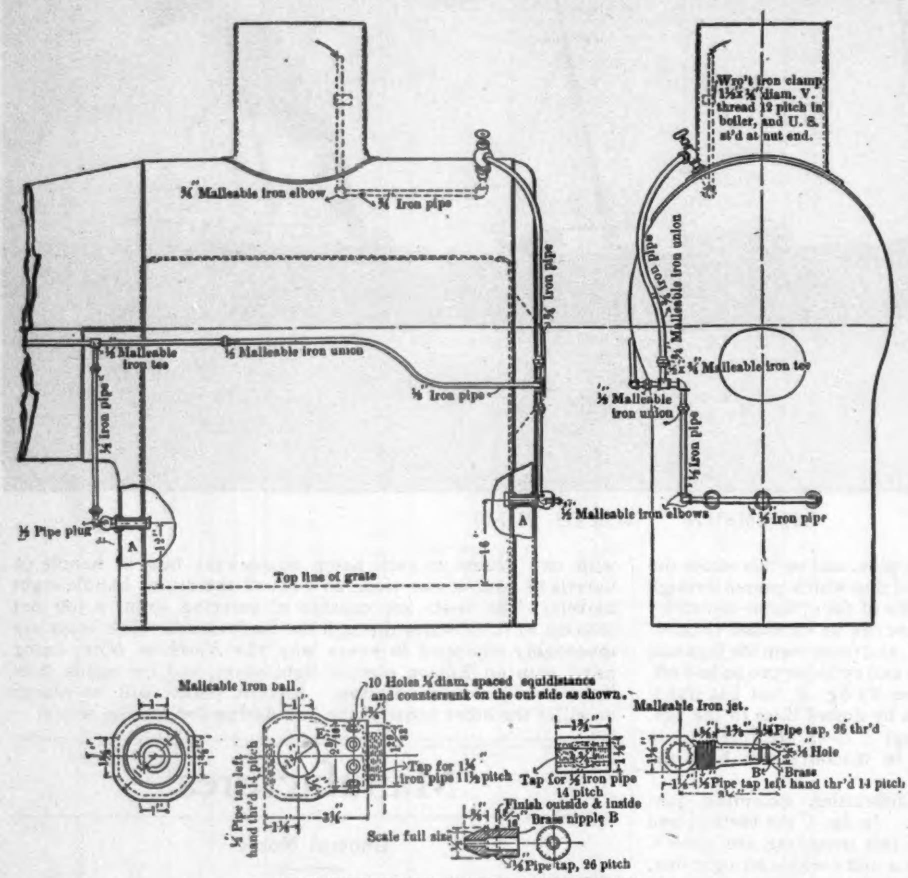
THE Buffalo Railroad Supply Company, which was recently incorporated with a capital stock of $100,000, has purchased five acres of land at the crossing of the Delaware, Lackawanna & Western, the Lehigh Valley, and the Western New York & Pennsylvania Railroads in Buffalo, and has begun the erection of large buildings, the principal one being 500 ft. in length and another 250 ft. These buildings will be fitted up with new machinery, and work will be begun as soon as possible. The Company will manufacture switches and fixtures, frogs and crossings, car-axles, links and pins, and many other articles used by railroads, besides making brass and iron castings of all descriptions and general machinery. It has succeeded to the business of the Buffalo Frog & Crossing Company, and has also acquired control of several patents for feed-water heaters, and purifiers for boilers. The officers of the Company are: Sydney E. Adams, President; M. M. Drake, Vice-President; W. A. Clemens, Treasurer; Virgil H. McConnell, Secretary and Manager. There are many advantages in Buffalo as a location for such business.

THE Arrow Steamship Company has one of its peculiar type of vessels now building in the yard of the Monumental Construction Company, Locust Point, Baltimore, under the super-

vision of the inventor, Robert N. Fryer. This vessel will be of iron, 222 ft. long over all ; 16 ft. extreme breadth ; 18.4 ft. deep, and will have a draft of 8 ft. forward and 10 ft. aft. Great expectations are entertained of this vessel, but its success is considered by experts somewhat doubtful. The ship will be propelled by a compound engine with cylinders 30 and 60 in. in diameter and 24 in. stroke, steam being furnished by two Ward boilers.

THE Detroit Dry Dock Company has let a contract for the building of a new dry dock, which will be the largest on the lakes. It will be 400 ft. long, 54 ft. wide at the bottom and 94 ft. on the water-line, with 16 ft. of water over the keel blocks at low water. The pumps will have a capacity of 36,000 galls. per minute. The dock has been designed by Mr. Frank E. Kirby, and will be of wood with a steel caisson gate.

ONE of the largest sailing ships in the world is the *Shenandoah*, which was recently launched from the yard of Arthur Sewall & Company in Bath, Me. This ship is 325 ft. in length over all ; 49 ft. beam, and 28 8 ft. in depth, with a registered gross tonnage of 3,407 tons. She will carry 5,000 tons of



HUTCHINSON'S SMOKE CONSUMER.

freight, and with that load will draw 27 ft. of water. She will have four masts and a total sail area of 11,000 yards. The rigging is all of wire, and all her fittings are of the most modern type, including steam windlass and hoisting drums, capstans, and power pumps. The keel and frames are of oak and hackmatack, and the upper works principally of yellow pine.

THE Bucyrus Steam Shovel & Dredge Company, Bucyrus, O., has sold two of its large shovels to the Cleveland Iron Mining Company and one to the Lake Angeline Mining Company. These shovels are made for handling hard and soft ore, and have a capacity of five tons per minute. It is claimed for them that they will load ore at about one-third the expense of hand labor.

A NEW wrought-iron paint which has been put upon the market is, it is claimed, the best existing material for protecting iron and steel surfaces from the influence of the weather. This paint is made from slag produced at a very high temperature, and the manufacturers claim that its constituents are present as chemical compounds, chiefly silicate of iron, unalterable under the conditions to which a pigment is liable to be exposed. The great weight of the pigment causes it to settle rapidly to the surface to which it is applied, and it clings to that surface with great tenacity, forming a layer of unusual durability. The vehicle used is pure linseed-oil, and no artificial dryer is required. This paint is laid on with a brush in the same way as ordinary paint, but the layers are heavier. It dries more rapidly than ordinary paint, and has, it is claimed, much greater adhesive power and resistance to water, air and other corroding elements. It is made in different colors for freight cars, car roofs, for bridges, and, in fact, for all iron and other work exposed to the weather. It is manufactured by the Aquila Rich Paint Company, of New York.

THE Bethlehem Iron Company, Bethlehem, Pa., has done a large amount of forging for the new cruisers of the Navy, a number of shafts and cranks having been made in the works. These include the shafts for the *San Francisco* and the *Monterey*, built by the Union Iron Works in San Francisco, the total weight of forgings for the former being 147,202 lbs. and for the latter 68,161 lbs. On the ships built in the Cramp yard in Philadelphia, the weight of forgings furnished was 147,113 lbs. for the *Philadelphia* and 118,820 lbs. for the *Newark*. For the engines of the *Maine*, under construction at the Quintard Works in New York, the weight of the forgings was 119,810 lbs. For cruisers Nos. 7 and 8, building at the New York and Norfolk navy yards, 53,579 lbs. of forgings were made. The total amount of heavy forgings thus furnished for the Government vessels to date is 756,621 lbs. altogether.

IT is stated that a half interest in the Priest flanger has been sold to Mr. W. E. Haskell, of Minneapolis, and that this invention, which has already met with much success, is to be actively pushed.

LAKE shipments of iron ore for the season are at an end, and the aggregate, 8,155,324 gross tons, is 1,251,324 tons greater than the shipments of 1889 and 3,433,337 tons greater than the shipments of 1888. Rail shipment of about 400,000 tons will bring the 1890 record up to 8,500,000 gross tons, or double that of all years previous to 1888. Shipments from the different ports were : Escanaba, 3,756,143 tons ; Ashland, 2,109,511 tons ; Marquette, 1,316,353 tons ; Two Harbors, 870,848 tons ; Gladstone, 86,558 tons, and St. Ignace, 15,911 tons. The Marquette Range shipped 2,656,423 tons ; Gogebic, 2,460,569 tons ; Menominee, 2,167,484 tons, and Vermillion, 870,848 tons.—*Cleveland Marine Review.*

THE Baldwin Locomotive Works in Philadelphia have received an order for 10 ten-wheel passenger locomotives for the New York, Lake Erie & Western Railroad.

THE Buffalo Car Manufacturing Company has just completed 200 box cars of 50,000 lbs. capacity for the Delaware, Lackawanna & Western Railroad.

The Hutchinson Smoke Consumer.

THE accompanying illustrations show a device for preventing smoke which has been prepared by W. S. Hutchinson, of Chicago, and has been introduced on the Lake Shore & Michigan Southern, the Baltimore & Ohio, the Chicago & Northwestern, the Chicago, Rock Island & Pacific and other roads.

The cuts, which include a rear and side view of the boiler and a plan and section, on a larger scale, of the steam-jet, show the device as applied to a Lake Shore locomotive. In this case the pipe was carried forward to supply a blower in the smoke-box, but that connection is a separate thing and independent of the smoke consumer.

The principle involved, as will be seen from the engravings, is simply that of a steam-jet to carry air into the fire-box above the fire, thus securing the consumption of the gases, etc., which would otherwise pass off through the flues and the smoke-stack. These jets are placed at each end of the fire-box, as shown, and are so arranged as to distribute the air over the surface of the fire.

The results obtained are said to be very good. The device can be applied to stationary boilers as well as to locomotives, as will be readily understood from the description.

Notes from Baltimore.

THE Maryland Central Railroad is to be changed from 3 ft. to standard gauge, so as to be able to exchange traffic with other lines. The connection will be made over the new Baltimore Belt Line.

WORK is being pushed on the extension of the Western Maryland Railroad from its present terminus in Baltimore to tidewater.

SEVERAL new establishments have been located at Curtis Bay, adjoining the South Baltimore Car Works. The South Baltimore Foundry Company has completed its plant and is now filling orders. Foundations have been laid at the same places for the Ryan-McDonald Machine Works. These works will be under the management of Mr. Howard Carlton, who is also General Manager of the Car Works.

THE proposed plan for using the bed of the Chesapeake & Ohio Canal for a railroad will not be carried out. The Baltimore & Ohio now has control of the canal, and is making arrangements to repair it and put it in operation.

THE Mt. Clare Works of the Baltimore & Ohio Railroad are busy on new work, having orders for six new consolidation engines, ten 10-wheel engines and four 8-wheel, class M, engines. In addition to this equipment, orders have been given to the Baldwin Locomotive Works for seven 10-wheel engines and for three 8-wheel passenger engines, the latter having driving-wheels 76 in. in diameter. The Company is putting up new shops just outside of Washington at a place which will be called Trinidad.

AT a general meeting of officers of the Operating Departments of the Baltimore & Ohio Railroad, held at Camden Station, in Baltimore, December 5, satisfactory reports were presented. President Mayer and Vice-President Orland Smith were present and made short addresses. The supply of fuel and oil were two of the subjects discussed.

THE heads of the Motive Power Department of the Baltimore & Ohio recently held a conference at Mt. Clare with a view of preparing forms to be used in connection with the piecework system. This system is in use in the shops east of the Ohio River, but some difficulty has been found in getting satisfactory forms for all classes of work.

New Bridges.

A NEW bridge over the Genesee River at Rochester, N. Y., has recently been completed by the builders, the Rochester Bridge & Iron Works. This bridge crosses the deep gorge of the Genesee at a height of 212 ft. above the river, and consists of one main three-hinged arch span 428 ft. in length, with a single approach span of 103 ft. at the east end and two approach spans of 93 ft. each at the west end, the total length being thus 717 ft. The depth of the main arch at the center is 14 ft. and at the ends 82 ft., the spring being 68 ft. The arch is composed of two trusses, which are inclined toward each other, being 20 ft. apart at the center and 46 ft. at the points of support. The bridge carries a roadway 20 ft. in width, and two sidewalks each 8 ft. wide.

THE new Verrugas Bridge on the Lima & Oroya Railroad, in Peru, has been completed. It replaces the famous Verrugas Viaduct, which was built in 1871 and destroyed by a flood in March, 1889. The new bridge will be secure from such an accident, as there are no piers in the center of the ravine which it crosses, and the failure of the old viaduct was caused by the undermining of the piers. The bridge, which was designed by Mr. L. L. Buck, is of the cantilever type, and is supported on two iron piers. The cantilever arms are each 235 ft. long and the suspended span is 105 ft. At the center it is 250 ft. above the bottom of the valley.

The Oroya Railroad has its present terminus at Chicla, 87 miles from Callao, and 12,300 ft. above the sea level. Arrangements are being made to complete the road from that point to the Cerro Di Pasco mines, and thence to some point on the upper waters of the Amazon. This was the plan originally laid down for the road, but interrupted by circumstances.

The Sault Ste. Marie Canal.

SOME idea of the importance of this canal may be formed from the following comparative statement of the business passing through it for the seasons of 1890 and 1889:

	1890.	1889.	Increase.	Per ct.
No. of lockages	4,970	4,684	286	6
No. of vessels passed	10,557	9,579	978	10
Registered tonnage	8,454,425	7,221,935	1,232,490	17
Tons freight carried	9,041,213	7,516,022	1,525,191	20
Estimated value of freight	$102,214,949	$83,732,527	$18,482,422	22

The average tonnage of freight carried per vessel this year was 856, against 784 in 1889, indicating an increase in the size and capacity of ships. The vessels passing the canal this year included 7,268 steamers, 2,872 sailing vessels, and 417 unregistered craft. The largest items of freight recorded were iron ore, coal, grain, and flour.

The *Marine Review* says: "Plans and specifications for the continuance of work on the new lock at Sault Ste. Marie have been completed in the office of General O. M. Poe, U. S. Engineers. This is the new work for which $900,000 were appropriated in the river and harbor act of September 19, with a proviso also that such contracts as may be desirable may be entered into by the Secretary of War for materials and labor for the entire structure and approaches, or any part of the same, to be paid for as appropriations may from time to time be made by law. Work under the contract shall be begun on or before May 15, 1891, and entirely completed on or before November 15, 1893. The approximate estimate of materials to be furnished and work to be done under the specifications is as follows: Portland cement to be delivered, 22,000 barrels; natural cement, 75,000 barrels; cut stone to be delivered, 20,000 cub. yds., solid measure; cut stone to be laid, 20,000 cub. yds., solid measure; backing to be delivered, 55,000 cub. yds., solid measure; backing to be laid, 59,000 cub. yds., solid measure; concrete to be laid, 5,000 cub. yds., measured in place; earth to be filled behind walls, 70,000 cub. yds., measured in place. The work required by the specifications is the building of the main walls and stairways of the 800-ft. lock, and the furnishing of all material, labor, and appliances needed for this purpose. The general character of the proposed work is similar to that of the lock now in use, which is called the lock of 1881 in the specifications, and the general outline of the work will be as shown in the drawings to be seen at the United States Engineer's Office, Detroit. The engineering skill necessary in the building of the new lock will again attract attention to great works on the lakes."

OBITUARY.

MAJOR P. W. O. KOERNER, who died in Atlanta, Ga., November 30, made the surveys for the first railroad proposed in Florida. He located the Florida Transit Road from Fernandina to Cedar Keys, and was engaged on several other railroads in the State.

MOORES MIRICK WHITE, who died in New York, November 29, was a pioneer among builders of iron bridges. He was a merchant at Syracuse, N. Y., for some years, and afterward engaged in bridge building, in which business he remained for a number of years. He was 81 years old at the time of his death, and retired from business some time ago.

THOMAS JEFFERSON WHITMAN, who died in St. Louis, November 25, aged 57 years, was born in Brooklyn, N. Y., and studied civil engineering under Mr. Kirkwood, who constructed the water-works of that city. In 1859 he removed to St. Louis, where he was engaged in planning and building the water-works, of which he was Chief Engineer and Superintendent for over 20 years. For some time past ill health has prevented him from engaging in active work.

WILLIAM B. KNIGHT died in Jacksonville, Ill., December 6, from injuries received in a railroad accident a few days before. He was born in New York in 1847, and was educated at the Rensselaer Polytechnic Institute in Troy, N. Y. He served as engineer on the New York Central, on the Panama Railroad, and on the sewerage works of Boston. In 1879 he removed to

Kansas City, where he was engaged in a number of important works, including the principal cable and electric railroad lines of the city. He was for four years City Engineer and held other responsible positions.

PERSONALS.

F. S. CURTIS has resigned his position as Chief Engineer of the Sinnemahoning Valley Railroad.

WOLCOTT C. FOSTER, of New York, has charge of the construction of the new water-works at Tarrytown.

W. H. KIPPLE has been appointed Chief Inspector of bridge and track material of the Pennsylvania Railroad.

S. H. OPDYKE, JR., has resigned his position as General Superintendent of the Central New England & Western Railroad.

CHARLES E. BILLIN has been appointed Superintendent of the Bridge and Construction Department of the Pennsylvania Steel Works.

J. W. PALMER, of Macon, Ga., is now Resident Engineer in charge of construction on the eastern end of the new Macon & Atlantic Railroad.

J. R. ROHRER has been appointed Division Engineer in charge of construction on the Ohio Extension of the Norfolk & Western Ohio Railroad.

S. H. H. CLARK has been appointed General Manager of the Union Pacific Railway. He will also retain his position as Vice-President of the Missouri Pacific.

WILLIAM F. TURREFF has been appointed Master Mechanic of the Chicago & Erie Railroad. He was formerly on the Cleveland, Cincinnati, Chicago & St. Louis.

ROBERT B. CABLE, recently on the Philadelphia & Reading, has been appointed General Manager of the Jacksonville, Tampa & Key West Railroad in Florida.

W. F. DONOVAN has been appointed General Manager of the Yale & Towne Manufacturing Company in place of SCHUYLER MERRITT, the last-named gentleman remaining with the Company as Secretary.

WILLIAM VOSS, formerly Master Car-Builder of the Burlington, Cedar Rapids & Northern Railroad, and later with the Fox Solid Pressed Steel Company, is now Master Car-Builder of the Illinois Steel Company.

GENERAL JOHN NEWTON, of New York, has been appointed Consulting Engineer to the Board of Trustees of the Chicago Sanitary District, and will have charge of the location and construction of the proposed drainage canal.

CHIEF CONSTRUCTOR T. D. WILSON, U. S. N., has been appointed Chief of the Bureau of Construction and Repair for a third term of four years. It is unusual for the Chief of a bureau in the Navy Department to serve more than two terms, and Mr. Wilson's reappointment is therefore a compliment to him, which will meet with general approval.

LEON G. BAGLEY has been appointed Railroad Commissioner of Vermont by the Governor of the State. Mr. Bagley began life as a messenger boy in St. Johnsbury, Vt., and rose to be Station Agent in that town. He subsequently removed to Rutland and was made Manager of the Western Union Telegraph office there, but was afterward in the marble business and more recently General Manager of the New England Insurance Company. His appointment to the Railroad Commission as a business man was strongly endorsed.

CHARLES FRANCIS ADAMS, JR., has retired from the office of President of the Union Pacific Company, in consequence of the recent changes in the controlling interest in the stock. Mr. Adams has been for a number of years recognized as one of the foremost authorities on railroad subjects. There has been a disposition in certain quarters to criticise Mr. Adams' management of the Union Pacific as not practical, but this is certainly not warranted, nor would such a position be taken by any one who knew the real condition of the Company when he was placed at its head. Few men have held a more difficult position than that he was called upon to fill; and it may be added that few could have filled it as he did.

COMMODORE CHARLES H. LORING, U.S.N., was placed on the retired list of the Navy December 18, having reached the statutory age of 62 years. He has seen 39 years of continuous and honorable service. He began his service in 1851, when he was appointed Third Assistant Engineer and assigned to the steam sloop *John Hancock*. From that time until he saw his last sea service as Fleet Engineer of the Asiatic Squadron, he served on all the principal ships of the Navy, including the *Princeton*, *St. Louis*, *Cincinnati*, *Susquehanna*, *Merrimac*, and *Minnesota*. He rose gradually to the rank of Chief Engineer, and in 1884 was made Chief of the Bureau of Steam Engineering. In 1888 he was relieved by Commodore Melville, and has since been on duty as President of the Experimental Board, with headquarters at the Brooklyn Yard.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, December 3, the Secretary announced the death of Thomas J. Whitman, St. Louis, Mo., formerly Vice-President of the Society. Amendments to the Constitution and a report prepared by the Committee on Revision were ordered printed and sent out. The Secretary read a list of a number of nominations which had been made for office.

Mr. J. A. Hall read an interesting paper on the Construction and Maintenance of Track, giving his own opinions and methods of practice, with a view to drawing out general discussion upon the same.

The tellers announced the following elections: *Members:* George H. Kimball, Cleveland, O.; H. M. Marshall, Vicksburg, Miss.; James Orange, Hong-Kong, China; William A. Pike, Minneapolis, Minn.; T. M. Rood, Mechanicville, N. Y.; William L. Scaife, Pittsburgh, Pa.; George C. Smith, Montevideo, Uruguay; R. Watkins, Sydney, N. S. W.

Juniors: William H. Chadbourne, Chadbourn, N. C.; A. C. Stites, Kansas City, Mo.; C. Davis, C. H. Dean, New York City.

Civil Engineering Society of the Massachusetts Institute of Technology.—At the 21st regular meeting, in Boston, November 20, Mr. H. C. Bradley read a paper on the Erection of Iron Bridges, and C. W. Sherman one upon the Disposal of Sewage at Worcester, Mass. An informal discussion of the methods of disposing of sewage sludge, the propagation of disease germs through water, and the various uses of chemical filtration closed the meeting.

New England Water-Works Association.—At the quarterly meeting in Boston, December 10, President Noyes made a short address. Professor Niles then made an address on Climatic Variations in their Relations to Water Supply, which contained many interesting facts.

Mr. Desmond Fitzgerald gave some details of the new reservoirs at Covington, Ky. Mr. Solon Allis read a paper giving an account of the replacing of some cement-lined pipe at Malden, Mass., by cast-iron pipe. Several other members spoke of the replacing of the cement-lined pipe in different places.

Connecticut Association of Civil Engineers & Surveyors.—At a meeting held in East Berlin, Conn., November 29, E. O. Goss and W. E. Johnson were elected members.

The report on Dam Legislation prepared by a special committee, was discussed at some length. Mr. C. M. Jarvis made an address on Bridge Construction, and Mr. C. H. Bunce read a paper on Asphalt Pavements, which was discussed.

Master Car-Builders' Association.—The Committee on Air-Brake Standards has issued a circular containing the questions below, which members are asked to answer, sending their replies to the Chairman, Mr. John S. Lentz, at Packerton, Pa.

"How many freight equipment cars have you equipped with M. C. B. standard air-brake details, *practically* like those shown in Plate X, *Proceedings* 1890?

"How many of the same cars are equipped with iron brake-beams?

"How many freight equipment cars have you equipped with iron brake-beams, and with brake details different from those above mentioned?

"Do you think that good results can be had and maintained by any form of wooden brake-beam with modern air-brake equipment, or do you consider that iron brake-beams are necessary for good results and economy?"

Engineers' Club of Philadelphia.—At the regular meeting, November 15, Mr. Robert J. Parvin, at the hands of the Secretary, presented a handsome pointer to the Club, to be used in

explaining the large illustrations often presented at the meetings. It was received with a vote of thanks.

The Secretary called attention to the question of contributions to the Club subscription to the proposed Engineering Headquarters and Congress at the World's Fair in Chicago.

The Secretary presented, for Mr. R. Taylor Gleaves, a description of Continuous Rails for Railways, which are carried upon ordinary ties of wood or iron weighted down with a covering of earth, gravel or stone, so that they cannot easily move. The spikes are not driven home by three-eighths of an inch, so that undulations may take place in the rail without disturbing either spikes or ties, and arrangements resembling turnouts are put in at fixed points, such as frogs, and at the foot of heavy grades, for the purpose of admitting of longitudinal motion.

After some discussion of this paper the meeting adjourned to lunch.

At the regular business meeting, December 6, a letter was presented from Captain S. C. McCorkle, accompanying the latest chart issued by the Coast Survey of Alaska, mentioning it in connection with the proposed railroad to Russia by way of Behring Straits.

It was ordered that a Committee of three be appointed to consider the best means of increasing interest in the Club and its meetings.

Mr. John E. Codman presented notes on the Rainfall in the Vicinity of Philadelphia in 1889, referring to the extraordinary storms of that year and giving a description of the automatic rain gauge used by the Philadelphia Water Department.

Mr. Strickland L. Kneass presented a paper on the Internal Condition of an Elastic Fluid During Discharge Through an Orifice. This paper described a number of experiments taken. These consisted of observations taken from a brass tube 0.3 in. in diameter, pierced by seven small holes. Upon these were placed pressure gauges, and the tension of the steam was obtained at seven different points of the tube; from this data was determined, and graphically shown, the velocity of the steam at every point of expansion between initial and terminal pressures.

The phenomena of discharge under some conditions were peculiar; one experiment showed an actual tension of the steam from 5 to 7 lbs. below atmospheric pressure, even though the tube was discharging freely into the air.

The paper closed with a description of a nozzle proportioned upon the theory of constant acceleration.

Mr. Wilfrid Lewis presented a description of a new Feed Ratchet invented by him.

Engineers' Club of Cincinnati.—At the November meeting of the Club there was an attendance of 29 members and several visitors.

One application for membership was received and three new members were elected: Messrs. H. C. Innes, H. E. Warrington and Percy Jones.

The paper for the evening, by Mr. John W. Hill, under the title of Some Remarks upon Water and Sewerage Works from a Sanitary Standpoint, treated at some length the important subjects of proper and sufficient water supply, drainage, and sewerage and garbage disposal.

Civil Engineers' Club of Cleveland.—At the regular meeting, December 9, Professors Harry F. Reid, Boswell C. Miller, Arthur Skeels, and Messrs. David Owen and Boswell H. St. John were elected active members. Mr. King, of Norwalk, O., was invited to address the Club, and explained some of the methods used and discoveries he had made in pure mathematics. Then followed a discussion of the Injurious Effects of Cement on Lime Mortar, which was opened by Mr. C. O. Arey and participated in by Messrs. Richardson, Eisemann, and Hermann, who had noticed in buildings that lime mortar to which cement had been added was weaker and not as hard as that in which no cement had been used. Mr. Thompson had noticed that cement mortar had failed to produce a bond between limestones when the same mortar would form an excellent bond with sandstones. Mr. Morse had seen buildings taken down where first-rate results were shown with the cement lime mortar. The present practice among Cleveland architects appears to be to use clear cement mortar or clear lime mortar, except in freezing weather, when a little lime is added to cement mortar to prevent freezing before setting.

Professor C. L. Saunders then read an interesting paper on Transmission of Power by Belt and Rope, giving an account of the recent improvements of the various substitutes that are used instead of leather belts, the means taken to prevent slip, some of which are more than worthless, diminish friction, and never increase their efficiency and reduce the expense. This was followed by a discussion by Messrs. Mordecai, Roberts, Barber, Swasey, Eisemann, Bowler, Benjamine, and Hermann. Mr. Swasey mentioned a patent coupling which seems to be very efficient, and for turning anglers an excellent substitute for a twisted belt, but thinks that the day of the leather belt is by no means past. Mr. Benjamine stated that a crossed belt has but 90 per cent. of the efficiency of a straight one, with one turn only 80 per cent., and with one-quarter turn and a guide pulley less than 30 per cent. Messrs. Eisemann and Bowler mentioned cases where ropes had been discarded and belts substituted on account of expense. Mr. Hermann thought this was caused by a defect in design or workmanship. Mr. Roberts thought that with slow-moving belts the atmosphere had but little to do with slip and resistance, but since the advent of the dynamo and a belt-speed of over 6,000 ft. per minute this requires more study.

Perforated belts appear to have done good service, and boring holes through the pulleys seems to have been of great advantage.

Mr. Benjamine states that a belt with a velocity of over 6,000 ft. per minute requires the most careful balancing in all its parts to increase efficiency and prevent injury from its great centrifugal force.

Engineering Association of the Southwest.—At the annual meeting in Nashville, Tenn., November 13, the Secretary, Professor O. H. Landreth, reported a total of 101 members of all classes. The total receipts were $602 and the balance on hand $377. Ten meetings were held during the year, and 10 papers were read.

The annual address of the retiring President, Mr. John McLeod, was read. It was a valuable and interesting summary of the general development of engineering during the year.

The following officers were elected for the ensuing year: President, John B. Atkinson; Vice-Presidents, William L. Dudley and Charles Hermany; Secretary, O. H. Landreth, Nashville, Tenn.; Treasurer, W. B. Ross.

Western Society of Engineers.—At the regular meeting, in Chicago, December 3, reports were received from the committees on Annual Meeting and on Nomination of Officers.

Mr. Otis K. Stuart read a paper explaining the construction of De Bausset's Air Ship.

Engineers' Club of St. Louis.—At the regular meeting, November 20th, Professor J. B. Johnson read a long paper on Aerial Navigation, which was briefly discussed by members present.

At the annual meeting, December 3, the Secretary presented his report, showing a total of 179 members. There were 22 meetings held during the year, at which 22 papers were read. The Executive Committee presented a report showing total expenditures of $1,529, and giving an attractive programme of papers promised for the meetings of the year. The standing committees also presented their reports.

The Nominating Committee presented the following names for officers for the ensuing year: President, George Burnet; Vice-President, N. W. Eayrs; Secretary, Arthur Thacher; Treasurer, C. W. Melcher; Librarian, J. B. Johnson; Directors, F. E. Nipher and S. Bent Russell.

Mr. J. A. Seddon read a paper on Economic Dimensions of Settling Reservoirs, the discussion of which was adjourned to the January meeting.

Montana Society of Civil Engineers.—At the regular meeting in Helena, Mon., November 15, Henry J. Horn, Jr., was elected a member. It was resolved to appoint a delegate to represent the Society on the General Committee to arrange for the International Engineering Congress in Chicago, in 1893.

A change in the time of meeting was discussed. Committees were appointed to arrange for the annual meeting to be held January 17, and to nominate officers for the ensuing year.

Northwestern Track & Bridge Association.—At the regular meeting in St. Paul, November 14, there was a paper read on Pile and Trestle Bridges, by Mr. Amos. This was followed by an extended discussion, in which notes of practice on different roads were given.

Mr. McMillan read a paper on Discipline and Management of Trackmen, which was followed by a short discussion.

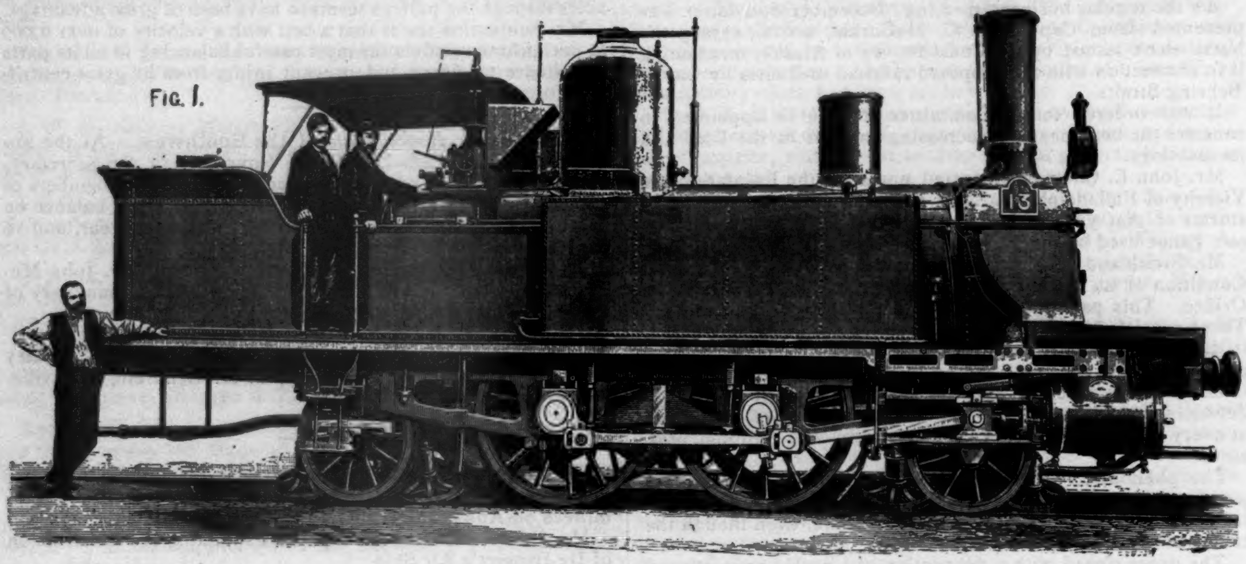
NOTES AND NEWS.

Railroad Gauges.—The *Engineer* says that no less than 39 different railroad gauges seem to have been in use between 1880 and 1889.

Old Rolling Stock for Sharp Curves.—The accompanying illustrations, from the London *Engineer*, show one of the locomotives in use on the Paris-Sceaux-Limours Railroad, a suburban line 40 km. (24.86 miles) long. Fig. 2 is an inverted plan showing the radial arrangement adopted for the cars, and the method of coupling. The draft from the axles and not from the car body is somewhat similar in type to the device in use on the elevated roads in New York. The railroad is being reconstructed, and will hereafter be worked with rolling stock of the ordinary French type.

Constructed in 1848, the line was conceded to the Paris-Orleans Company in 1866, and this date, along with the name

FIG. I.



of M. M. V. Forquenot—late Chief Engineer of Traction of that company—is borne by the name plates of many of these engines. Being built at Ivry—the Paris shops of the Orleans line—these engines might be supposed to resemble the standard designs of that road; but, instead, they have remained differentiated distinctly in their characteristics from any regular French locomotives. The peculiarities of the Limours Railroad is that the gauge is 1.75 m. (5 ft. 8.8 in.). The terminal

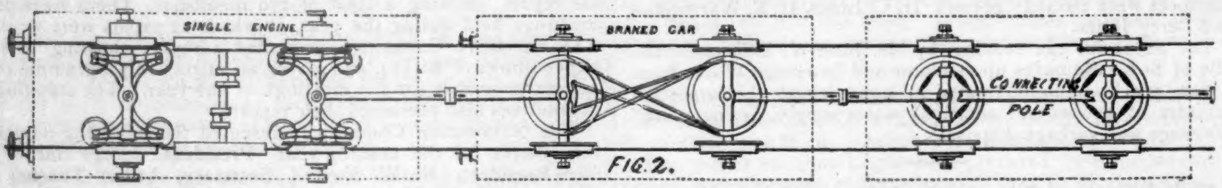


FIG. 2.

stations at Paris, Sceaux, and Limours are circular in form, the two tracks entering into a single loop of 81 ft. radius, making an endless railroad, and, in addition, between Bourg-la-Reine and Sceaux there exists an S curve along the ridge of a valley having one curve of the same radius.

Under these conditions, the rolling stock, which has been in use so many years, is also peculiar, and perhaps not readily understood when we think of the numerous radial contrivances in use to-day. The small cars are carried on four wheels, each axle being free to swivel around under a circular frame beneath the carriage body, an arrangement analogous to that of an ordinary road vehicle, but each axle-frame is connected by a central pole, and two diagonal rods from the periphery of each side of the leading frame cross to the opposite side of the next circular frame, by which means leading wheels, turning inward to the left, cause the following pair to turn equally outward to the right, and the long hallow bar attached to this last steers the first axle of the following vehicle in the same circular course—this pole being at once the coupler, draw-bar, and springless buffer. This axle radiating arrangement has been patented and repatented in England. Naturally there is no strain of traction whatever upon the car bodies themselves. For the engine the radial movement is of the same principle, but different in detail. In place of the swivel or locking carriage a section of a circle is fixed to the ends of the leading and trailing journals, and these curved brackets support the spring blocks above. Although free to turn within the radius allowed by the frame pivoted under the center of the engine frame, the trucks each carry a set of four guard wheels with beveled edges, which are mounted at an angle of about 25° with the inner edge of the rails, and really guide the bearing-wheels more than the flanges on the latter. The driving-wheel treads are without flanges, 11¾ in. on the face of the tire. To permit the necessary clearance required by the oblique guide-wheels the switch-points with butt ends have a clear displacement of about 5 in. However well this engine has been suited to the special requirements of the line—which has at least one gradient of 1 in 50—the cost of maintenance due to such curves, and the disadvantage of the gauge restricting intercommunication with other lines, have decided the engineers to adopt the standard gauge; the ordinary arrangement for terminal stations; the regular fixed-base four-wheel coach, and a rigid-wheel locomotive of special design more powerful than the present, and which should haul a greater number of coaches, since the new ones, it is said, will differ very little in weight from those now used—15,400 lbs. At present, the best time made between stations averages only 34 miles an hour, although 40 miles per hour are made occasionally. On the 25-meter curves the trains are regulated to nine miles, and on the longer deflections to 19 miles per hour, and on account of this low speed the super-elevation of the outer rail is really less than adopted for ordinary short curves. A full train consists of 15 cars, weighing about 100 tons without the locomotive.

Brooklyn Bridge Traffic.—In accordance with the yearly custom, a careful count of the passengers crossing the Brooklyn Bridge was made on Tuesday, November 25. The total number was 133,040, an increase of 13,212, or about 11 per cent., over the number on the counting day last year. The average was 5,543 per hour, but the distribution was very uneven, as might be supposed. The smallest number counted as crossing in an hour was 379, between 2 and 3 A.M.; the largest, 17,538 between 5 and 6 P.M. The larger number gives an average of 292 a minute, which gives some idea of the rush in busy hours.

The number of vehicles also fluctuated very much, the smallest number in an hour being 23 between 1 and 2 A.M.; the largest 436—over 7 per minute—between 4 and 5 P.M.

Combined Engine and Dynamo.—The accompanying illustration shows a combined engine and dynamo, which is one of a set of three recently completed for the Birmingham Post Office. The engine is by Messrs. Willans & Robinson, Lim-

ited, of Thames Ditton, and is designed to develop 80 H.P. at 450 revolutions.

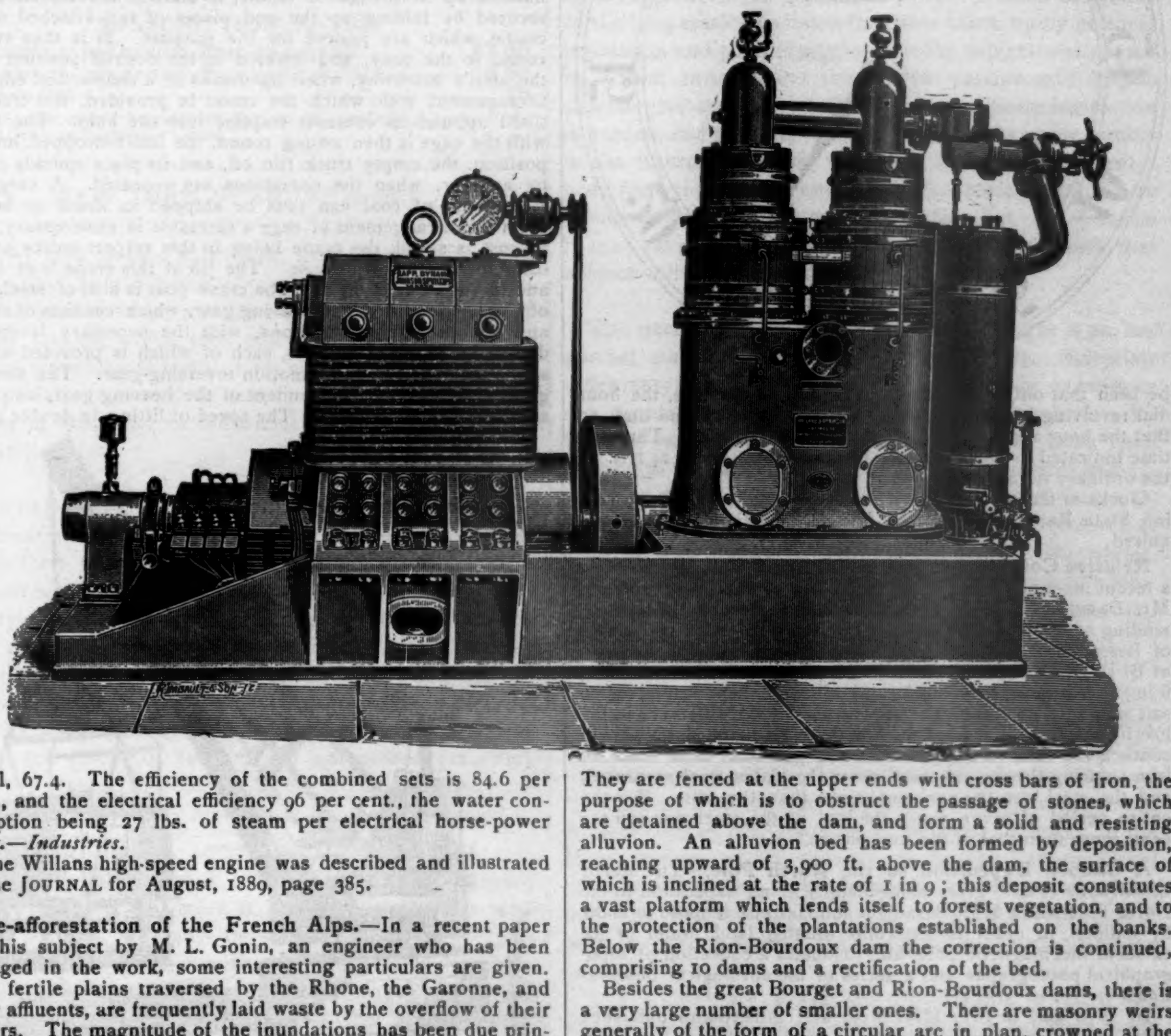
The dynamo is built by Messrs. Johnson & Phillips, of Union Court, London. The design is that of Mr. Gisbert Kapp. The output is 112 volts and 450 amperes at 450 revolutions per minute. The armature is of the drum type, the core being built up of iron disks. The end connections are arranged according to a patent of Mr. Kapp's. The connectors form a compact mass, which is put together independently, and then put on the armature like a commutator. The connectors are semicircular punchings of sheet copper, with a lug at each end. These lugs are bent right and left, forming when the connection is built up circular rows, to which the ends of the armature bars are attached. The field magnets have 15,400 ampere turns in the shunt, and 6,600 in the main; and about 1,094 watts in the two together. The armature is 15 in. in diameter, and has 102 external conductors, and full load loss of 1,095 watts.

Elaborate tests have been carried out to determine the efficiency of the combined set. The water used in one hour was 1,700 lbs.; the indicated horse-power, 79.7; and the electrical, 67.4. The efficiency of the combined sets is 84.6 per cent., and the electrical efficiency 96 per cent., the water consumption being 27 lbs. of steam per electrical horse-power hour.—*Industries.*

The Willans high-speed engine was described and illustrated in the JOURNAL for August, 1889, page 385.

Re-afforestation of the French Alps.—In a recent paper on this subject by M. L. Gonin, an engineer who has been engaged in the work, some interesting particulars are given. The fertile plains traversed by the Rhone, the Garonne, and their affluents, are frequently laid waste by the overflow of their waters. The magnitude of the inundations has been due principally to the increasing development of the torrents, especially those of the Alpine departments, caused by the destruction of the mountain forests and grass lands, and the disappearance of the vegetation by which the soil was protected, which, like a sponge, retained the rainfall, moderated the flow of the waters, reduced the floods, and acted as a protection against erosion of the soil.

As a remedy the torrents were to be arrested at their source; the materials removed by the waters were to be retained in the valleys or defiles; the formation of ridges and furrows, and the generation of new torrents in the bared places of the hills had to be opposed; vegetation had to be revived and protected from the sheep which find pasture in the mountains. To carry out these objects, two kinds of works were necessary: 1. The correction and regulation of the torrents by establishing a system of dams; 2. The replanting of the ground with wood and grass. The course of a torrent is divisible into three stages: the collecting basin, the outflow gorge and the settling bed in the form of a cone, in which the eroded matter brought down by the current is deposited. The valley of the Barcelonnette presents one of the most complete types of torrents. The Rion-Bourdoux dam is the most important of those in the valley. Its cone of deposit of the torrent covers an area of 600 acres—an area of desolation. The dam is 26½ ft. high above the bed, and has a width of 274 ft. The crown is 10½ ft. thick, and the wall slopes at the rate of 1 in 5 to the bottom. The foundations are 18¾ ft. thick and 14¾ ft. deep. The crown of the dam, in horizontal plan, forms a circular arc of 170¼ ft. radius. In elevation it presents a level platform 65¼ ft. long, joined to a circular arc at each end of 112 ft. radius, having a rise of 13 ft. at each end, and 52½ ft. long. They make a total width of 170¼ ft., and are finished with an earth formation at each end. The dam is constructed entirely of hydraulic masonry in very large blocks. It is loop-holed by five openings near the bottom, and six smaller holes at a higher level, for the passage of water and liquid mud; but the lower openings alone are in operation, the upper ones being stopped up.



They are fenced at the upper ends with cross bars of iron, the purpose of which is to obstruct the passage of stones, which are detained above the dam, and form a solid and resisting alluvion. An alluvion bed has been formed by deposition, reaching upward of 3,900 ft. above the dam, the surface of which is inclined at the rate of 1 in 9; this deposit constitutes a vast platform which lends itself to forest vegetation, and to the protection of the plantations established on the banks. Below the Rion-Bourdoux dam the correction is continued, comprising 10 dams and a rectification of the bed.

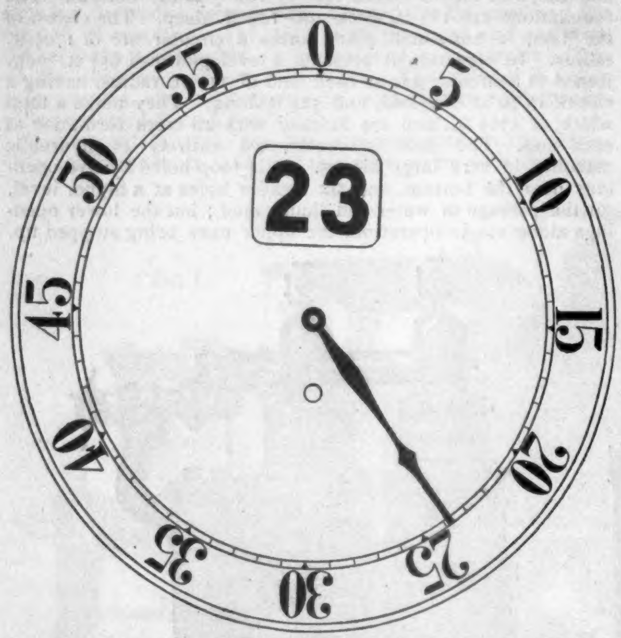
Besides the great Bourget and Rion-Bourdoux dams, there is a very large number of smaller ones. There are masonry weirs generally of the form of a circular arc in plan, crowned at the summit by a horizontal platform as wide as is practicable and finished at the ends with arcs of circles. The stream is thus spread out into a comparatively thin sheet, and the erosive force of the fall at the foot is minimized. These dams are increased in height from time to time in proportion as the deposit above accumulates. An opening is made through the wall near the base for the passage of water with solid matter in suspension.

For the smaller dams, owing to the want of stone, wood in the form of wattle fences and fascines is employed. According to one mode of construction two rows of stakes, in larch and willow, are planted across the bed of the torrent, with willow branches interlaced, forming the body of the structure. The stakes are bound together by a longitudinal timber laid horizontally a little below the level of the crown. Behind the dam, for its protection, a body of earth and small stones is placed.

It is planted with slips of trees, by the growth of which the consolidation of the work is promoted.

In the valley of the Barcelonnette there are nearly 3,000 dams, 71 being large structures and 2,916 small ones of wood. The total expenditure in this valley has been about $553,000, including general charges.

A Clock Dial for 24-Hour Time.—The accompanying engraving, from *Indian Engineering*, shows the standard dial for 24-hour clocks adopted by the Indian State Railroads. It will



be seen that only a minute hand is used on the face, the hour dial revolving inside, instead of being marked on the dial, so that the hour appears through the slot in the face. Thus the time indicated in the engraving is 23:24—that is, 11:24 P.M. in the ordinary notation.

Clocks of the pattern shown are to be supplied to all the Indian State Railroad offices, as fast as new time-pieces are required.

Relative Corrosion of Iron and Steel in Salt Water.—At a recent meeting of the British Institute of Marine Engineers, Mr. David Phillips stated that he had made experiments extending over seven years—from 1881 to 1888—with two pieces of Bessemer steel boiler plate, two of Yorkshire iron, and two of B. B. Staffordshire iron. All the plates were the same size, 6 in. × 6 in. and ⅜ in. thick, and all were kept immersed in salt water. The results showed a considerable difference in the loss by corrosion. During the first three years the plates were in contact, and the steel plates lost 120 per cent. more than the iron; during the second three years the plates were separated, and the steel lost 124 per cent. more than the iron. For the entire period of seven years the loss of the steel was 126 per cent. more than that of the iron plates.

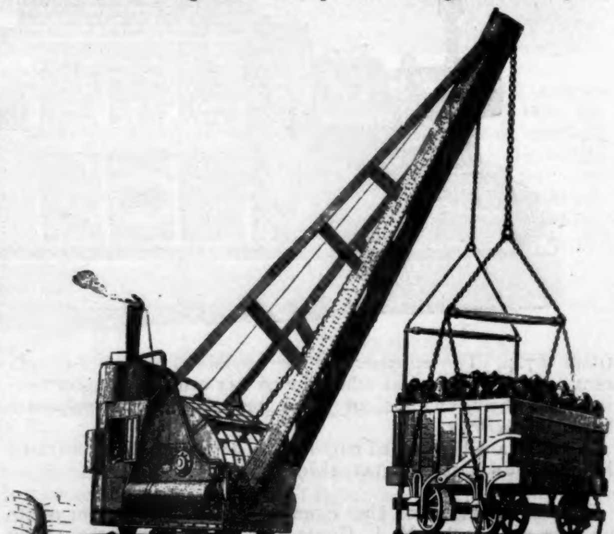
A Balloon Expedition to the North Pole.—The *Revue Scientifique* (Paris) gives some details of an expedition to the North Pole which MM. Besançon and Hermite propose to make by balloon, in order to ascertain whether land, water or ice exists at the magnetic pole, and to obtain a collection of topographical photographs and a series of meteorological observations.

In 1870 and in 1874 MM. Sivel and Silbermann published some studies on the possibility of such a voyage, but MM. Besançon and Hermite now intend to reduce the matter from theory to practice, and have decided to build a balloon which will do the work. This balloon, which will be inflated with pure hydrogen, will have a capacity of 15,000 cubic meters (529,313 cub. ft.) and will be able to raise 16,500 kg. (36,366 lbs.). It will be composed of two thicknesses of China silk, and will be capable of resisting a pressure of 1,000 kg. The bag will be covered with a special varnish having a base of oil and collodion, which, it is believed, will make it absolutely impermeable to gas.

The travelers will carry with them four small pilot balloons having a capacity of 50 cub. m. (1,764 cub. ft.) each, which are to be set free above the pole to test the aerial currents; also four balloons, each of 350 cub. m. (12,350 cub. ft.) capacity, which will serve as reservoirs, to keep up the supply of gas in the large balloon. In order that the main balloon may not rise too high, and may be kept at a certain distance from the earth, to permit regular photographic observations, it will be provided with a heavy guide-rope, attached to the car, which will drag upon the ice or float on the water, and which, in case of excessive expansion of gas, will serve as a drag or moving anchor.

The car will be constructed of wicker-work protected by an outer shell of thin steel; it will be made so that it can be entirely closed, to protect the passengers from excessive cold. Besides the observers it will carry their instruments and provisions for a month, and also a life-boat of very light construction, a dog-sledge, and eight dogs, to provide for return in case of accident to the balloon. The expedition will cost about $110,000; it will be ready to start in 1892, and will occupy about six months.

A Steam Wharf Crane.—The accompanying illustration shows a 25-ton steam crane built by the firm of Shanks & Son, Arbroath, Scotland. It is used for loading vessels with coal in a way which will be easily understood from the illustration. When the loaded car has been run alongside the crane, it is hoisted up in a cage or cradle, as shown, the wheels being secured by folding up the end pieces of rail attached to the cradle, which are jointed for the purpose. It is then swung round to the quay, and lowered to the desired position over the ship's hatchway, when by means of a simple and efficient arrangement with which the crane is provided, the truck is tilted up, and its contents emptied into the hold. The truck with the cage is then swung round, the latter dropped into its position, the empty truck run off, and its place quickly taken by another, when the operations are repeated. A cargo of 1,000 tons of coal can thus be shipped in about 10 hours. With this arrangement of cage a turntable is unnecessary, and its cost is saved, the crane being in this respect unlike others used for a similar purpose. The jib of this crane is of steel, and has a radius of 25 ft. The crane post is also of steel, and of ample strength. The heaving gear, which consists of single and double purchase motions, with the necessary levers, is driven by a pair of engines, each of which is provided with a set of case-hardened link-motion reversing-gear. The slewing gear (which is quite independent of the heaving gear) also consists of a pair of engines. The speed of lifting, in double gear,



is 20 ft., and in single gear, 40 ft. per minute, and that of slewing 70 ft. per minute; but all may be varied as desired. The plan of having separate engines for the lifting and slewing motions is adopted to obviate the necessity for using engaging and disengaging clutches, the latter arrangement being not only hard work for the operator of the crane, but also dangerous when heavy weights are being lifted. The boiler, which is of the vertical type, is of ample power. The crane is provided with a sheet-iron house, having a glass front, as shown in our illustration, affording protection from wet weather to both the workman and machinery.—*Iron.*